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COMPUTER PROGRAMS TO PREDICT INDUCED EFFECTS OF JETS EXHAUSTING INTO A CROSSFLOW

by

Stanley C. Perkins, Jr. and Michael R. Mendenhall

SUMMARY

This document is a user's manual for two computer programs developed to predict the induced effects of jets exhausting into a crossflow. Program JETPLT predicts pressures induced on an infinite flat plate by a jet exhausting at angles to the plate and Program JETBOD, in conjunction with a panel code, predicts pressures induced on a body of revolution by a jet exhausting normal to the surface. Both codes use a potential model of the jet and adjacent surface with empirical corrections for the viscous or nonpotential effects. This program manual contains a description of the use of both programs, instructions for preparation of input, descriptions of the output, limitations of the codes, and sample cases. In addition, procedures to extend both codes to include additional empirical correlations are described.

INTRODUCTION

During transition of a jet V/STOL aircraft from hover to forward flight, a complicated interaction between the jet exhaust and the crossflow results in induced pressure loadings on the aircraft in the vicinity of the jets. The integrated effect of these jet-induced pressure loadings can be a lift reduction and/or increase in positive pitching moment.

Investigations of the effects of a jet on the pressure distribution on an infinite flat plate and a body of revolution have been carried out by Nielsen Engineering and Research, Inc. (NEAR) (references 1 and 2) in an effort to understand the more complicated jet/wing and jet/fuselage interference problem. An analytical method which models the blockage and entrainment properties of the jet and corrects for the viscous effects behind the jet using empirical correlations has been developed by NEAR. The method predicts pressures induced on an infinite plate by jets exhausting at angles to the plate and on a body of revolution by jets exhausting normal to the body surface. Two separate computer codes were developed to implement the methods; Program JETPLT for the flat plate and Program JETBOD for the body of revolution. Details of the potential flow models used to describe the jet and of the empirical method used to model viscous effects are presented in references 1 and 2.

This document is the program user's manual for both JETPLT and JETBOD. The following sections of this manual provide a detailed description of the programs including the calculation procedure, individual subroutine descriptions, and limitations of the codes. General input to the codes and typical output are described, and specific sample cases designed to exercise the programs capabilities are presented. The procedure to extend both codes to include additional empirical correlations is also described.

SYMBOLS

A_i	area of segment of circular flat plate, see figure 7
A_{max}	total area of circular flat plate, πr_{max}^2
C_m	pitching-moment coefficient, $-\frac{1}{r_{max}A_{max}} \sum_{i=1}^{n} C_{p_i} A_i x_{m_i}$, see figure 7
C_n	normal-force coefficient, $-\frac{1}{A_{max}} \sum_{i=1}^{n} C_{p_i} A_i$, see figure 7
C_p	pressure coefficient, $(p - p_\infty)/q_\infty$
C_{p_i}	pressure coefficient at area centroid of segment of circular flat plate
D	jet diameter at the exit plane
p	static pressure
q_∞	dynamic pressure, $\frac{1}{2}\rho_\infty V_\infty^2$
r	radial distance along the plate from the center of the jet to any field point on the plate
r_{max}	radius of the circular plate (used in normal force and pitching moment calculations), see figure 7
R, r_o	jet radius at the exit plane
S_a	curve length of the jet axis
t	local jet radius
u,v,w,	velocity components in the x, y, and z directions, respectively
V_j	jet velocity at the exit plane
V_∞	constant free-stream velocity

x,y,z	plate or body coordinate system, see figures 1 and 19
x_j,y_j,z_j	jet coordinate system fixed at center of jet exit plane, positive x_j is downstream
x_{m_i}	local moment arm of area A_i, see figure 7
β	polar angle, measured clockwise from the positive x-axis in the plate x-y plane, see figure 1
$(\Delta C_p)_{viscous}$	correlation increment of pressure coefficient
δ_j	initial inclination angle of jet centerline, measured from the positive x_j-axis in the x_j-z_j plane, $\delta_j = 90° - \theta$; see figure 1
θ	initial inclination angle of jet centerline, measured from the positive z_j axis in the x_j-z_j plane, $\theta = 0°$ for a jet issuing normal to the free stream, see figure 1; or circumferential angle used in laying out out panels to model body of revolution
ρ_∞	density
ϕ	circumferential angle, measured from top of body of revolution, see figure 19

<u>Subscripts</u>

j	jet quantity
max	maximum value
∞	free-stream quantity

PROGRAM JETPLT

GENERAL DESCRIPTION

The computer code, JETPLT, described in this section has application as an engineering prediction method for subsonic jets exhausting from an infinite plate into a subsonic free stream (figure 1). The methods incorporated in this code are described in detail in references 1 and 2. The code provides a means to predict jet-induced pressures on a plate in the vicinity of the jet, as well as a means to calculate jet-induced normal-force and pitching-moment coefficients on finite plates.

The code consists of a main program, JETPLT, and 22 subroutines. The subroutine calling sequence for the program is shown in figure 2 where the general relationship between the subroutines and external references is illustrated. The main program, JETPLT, acts as an executive routine and directs the flow of the computation between the various program components. A cross reference table for the calling relationship between the program subroutines and the external references is shown in figure 3, and a similar table for the common blocks is shown in figure 4.

The program is written in standard FORTRAN language for use on a VAX 11/780 computer. Operation requires the usual input and output logical units. Execution time on the same computer can vary from two to six minutes. Execution time depends on many factors such as the number of plate field points, the number of points describing the jet centerline, and the number of panels used for the jet blockage model.

SUBROUTINE DESCRIPTIONS

The main program and the subroutines are briefly described in this section to provide a list of the contents of Program JETPLT.

JETPLT	Executive program for calculating the pressure distribution induced on a flat plate by a jet exhausting from the plate.
CLPT	Subroutine to set up jet centerline quantities and their derivatives.
CNRPT	Executive routine for determining coordinates of corner points of quadrilateral panels.
DELCP	BLOCK DATA routine which contains the viscous correlation factors for a jet exhausting from a flat plate. The factors are contained in data statements for a range of jet initial inclination angles and jet-exit to free-stream velocity ratios, and are presented as a function of radial distance from the jet center (r/D = 0.75, 1.0, 1.5, 2.0, 3.0, 5.0) and polar angle (β = 0, 30, 60, 90, 120, 150, 180 degrees).
ENTRAN	Subroutine for calculating entrainment model induced velocities at the plate field points using the empirical method of Yeh (European Space Research Organization TT-159, May 1975).
FIX	Subroutine for obtaining the viscous correlation factors by interpolating in the tables presented in BLOCK DATA subroutine DELCP.
FORCE	Subroutine for calculating the normal-force and pitching-moment coefficients on a finite radius plate.
GAMSLV	Subroutine for setting up linear equations in unknown vortex strengths for the blockage model quadrilateral panels.
INRAD	Subroutine to determine radius of curvature and center of curvature of jet centerline.
INVER2	Subroutine to solve simultaneous equations.
JET	Subroutine to input and print out jet parameters, jet centerline coordinates, and radius distribution.

JETBLK — Executive routine to input jet blockage model information and set up jet blockage model geometry.

JETVIN — Subroutine for calculating blockage model induced velocities at a plate field point.

JGEOM — Subroutine which organizes calls to various subroutines to obtain the jet blockage model, including the quadrilateral panel vortex strengths.

PDIST — Subroutine for computing vector RP from point X1, X2, X3 to each corner point of each quadrilateral panel.

QCPQN — Subroutine for determining coordinates of control points on each quadrilateral panel and direction cosines of unit normal to each panel.

QVC — Subroutine for computing influence matrix, QV, for the blockage model quadrilateral panels.

SADIF — Subroutine for determining the XCLR and ZCLR centerline coordinates corresponding to centerline distance S0 by interpolating in the jet centerline coordinate table.

SIMP1 — Simpson Rule integration routine.

SINTGX — Function used in conjunction with a Simpson Rule integration routine to calculate the x-component of velocity induced at the plate field points by the jet entrainment model.

SINTGY — Function used in conjunction with a Simpson Rule integration routine to calculate the y-component of velocity induced at the plate field points by the jet entrainment model.

TMXSR — Subroutine for determining coordinates of corner points of each quadrilateral panel.

UINF — Subroutine for setting up external velocity field, which is a uniform free stream in -x direction (plate coordinate system).

INPUT DESCRIPTION

The purpose of this section is to describe the input to Program JETPLT. The input formats are shown in figure 5, and the definitions of the individual variables are provided in following paragraphs. The order follows that shown in figure 5 where the input format for each item and the location of each variable on each card is presented. Data input in I-format are right justified in the fields and data input in F-format may be placed anywhere in the field and must include a decimal point. Note that many length parameters in the input list are dimensional variables; therefore, special care must be taken that all lengths and areas are input in a consistent set of units.

Provided at the end of this section are instructions for setting up input for the jet centerline shape, spreading rate, and blockage model. These instructions coupled with the sample cases in a later section should make it relatively easy for the user to set up the input for any typical jet in a crossflow case.

Item 1 is a single card containing two integers, each right justified in a five-column field.

Item	Variable	Description
1	NHEAD	number of header cards to be input in Item 2
	NCYL	number of entries in jet centerline table describing the jet in Item 4 (NCYL > 3)

Item 2 is a series of NHEAD cards containing hollerith information identifying the run. The information is reproduced in the output just as it is input.

Item	Variable	Description
2	TITLE	NHEAD lines of information to be printed at the top of the first page of output

Items 3 and 4 contain jet geometry information. Item 3 is a single card and Item 4 is a set of NCYL cards. The plate and jet coordinate systems are shown in figure 6 and information regarding jet centerline shape and jet spreading rate is given following this section.

Item	Variable	Description
3	GAMVJN	ratio of jet-exit velocity to free-stream velocity
	XO,YO,ZO	coordinates of the origin of the jet in the plate coordinate system, figure 6
	THETA(1)	inclination angle of jet at exit plane, degrees; measured in the plane of free-stream flow and equal to 0° for a jet issuing normal to plate, figure 6
4	XCLR(N), YCLR(N), ZCLR(N)	coordinates of the jet centerline in the jet coordinate system, figure 6
	AJET(N)	dimensional radius of jet along the centerline

Item 5 is a single card containing output and calculation options.

Item	Variable	Description
5	NVEL	Velocity calculation options: =0, total velocity calculation =1, entrainment model velocity calculation only =2, blockage model velocity calculation only
	NOUTA	=1, output quadrilateral panel corner points =0, above quantities not output
	NOUTB	=1, output quadrilateral panel control points =0, above quantities not output

Item	Variable	Description
5	NOUTC	=1, output individual blockage model induced velocities =0, above quantities not output
	NOUTD	=1, output individual entrainment model induced velocities =0, above quantities not output
	NFORC	=1, total normal-force and pitching-moment coefficients are calculated =0, above quantities not calculated

Items 6 and 7 contain input for calculating normal-force and pitching-moment coefficients on a finite circular plate. To compute the loads on the plate, pressures are calculated at area element centroids of a circular plate and then integrated over the plate. The area elements are formed by radial positions input by the user (R(1) through R(NR)) and angular divisions determined in the program. The angular divisions are determined from BETA1, such that $\beta(1)$ = BETA1/2 and $\Delta\beta$ = BETA1. The points at which pressures are calculated are the area element centroids along the β = constant lines. A typical layout for a force and moment calculation and the positive sense of the force and moment are shown in figure 7.

Omit Items 6 and 7 if NFORC = 0 in Item 5.

Item	Variable	Description
6	BETA1	polar angle increment, degrees (360/BETA1 must be an integer)
	NR	number of radial positions to be input in Item 7
7	R(J)	r/r_o positions along which circular plate is divided to form the area elements, figure 7

Items 8, 9, and 10 contain information for a typical run to calculate pressures at field points on the plate. Field points are determined at the intersection of β = constant and r = constant lines. The range of values for the polar angle, β, is 0° to 180°, and the range of values for the nondimensional radial distance, r/r_o, is 1.5 to ∞. The first "N" field point coordinates are determined in the program along β = BETATH(1) for r_1/r_o to r_N/r_o. Therefore, XP(1), YP(1) correspond to r_1/r_o, β = BETATH(1) and XP(N), YP(N) correspond to r_N/r_o, β = BETATH(1). The next set of coordinates starts with XP(N+1), YP(N+1) which correspond to r_1/r_o for β = BETATH(2). For a typical field point layout, such as that illustrated in figure 8, BETATH (1) = 0°, BETATH(NBETA) = 180°, and the BETATH values are equally spaced; however, these are not requirements for the field point input. The only requirement for the polar angle input is that all values of BETATH(I) lie between 0° and 180°.

Omit Items 8, 9, and 10 if NFORCE = 1 in Item 5.

Item	Variable	Description
8	NBETA	number of polar angles to be read in Item 9
	NR	number of radial positions to be read in Item 10
9	BETATH(I)	polar angles along which field points are specified, degrees; figure 8
10	R(J)	radial positions, nondimensionalized by initial jet radius, at which field points are specified, figure 8

Items 11 and 12 contain information to define the jet blockage model. The jet is divided along its axis into NDS major sections, each of which is divided into NDSI segments (see figure 9(a)). The blockage model panels each subtend an angle of 360/NPHI degrees and the orientation of the front panel with respect to the free-stream direction is given by PHIO (figure 9(b)).

It is recommended that PHIO be set equal to 180/NPHI degrees. The dimensional panel length (along the jet axis) for each segment within a given section is given by DSI. It is recommended that NDS, NDSI, and DSI be such that the length of the blockage model is about the same as the length of the jet as given by the jet centerline input (Item 4). It is also recommended that DSI be equal to r_o or less for sections close to the jet exit and greater than r_o for sections farther from the jet exit. A maximum of 200 blockage model panels is allowed.

Item	Variable	Description
11	NPHI	number of circumferential segments into which jet cross-section is divided
	NDS	number of major sections along jet centerline into which the jet is divided (1 < NDS < 5)
	NDSI(NK)	number of segments along jet centerline into which each of the NDS sections are divided; NK = 1, NDS
12	PHIO	orientation angle of front panel, 180/NPHI recommended
	DSI(NK)	panel length (longitudinal) of the segments within each section; NK = 1, NDS

INPUT PREPARATION

In this section, the individual flow models of the jet model are described briefly and instructions on correctly specifying input for each of the models are given. The previous section on the input description must be used to understand the individual variables which go into JETPLT, and this section will permit the user to select the appropriate input to achieve maximum success with the code.

Jet Centerline Model

The jet centerline, at initial inclination angle δ_j to the plate, is shown in figure 1. The path of the jet centerline is specified using the following empirical relation developed by Margason (reference 3)

$$\frac{x_j}{D} = \frac{1}{4\sin^2\delta_j}\left(\frac{V_\infty}{V_j}\right)^2\left(\frac{z_j}{D}\right)^3 + \frac{z_j}{D}\cot\delta_j \tag{1}$$

where D is the jet diameter at the plate. Figure 10 shows the jet centerline shapes given by equation (1) for a range of velocity ratios with $\delta_j = 90°$ and 60°. Note that the relation between δ_j and θ is given by

$$\delta_j = 90° - \theta \tag{2}$$

Jet Blockage Model

A jet exhausting from an infinite plate into a subsonic free stream has been observed to exhibit a displacement effect as though the jet boundary were behaving as a solid surface, particularly near the surface of the plate (references 4 and 5). The effect of the solid jet boundary is obtained by representing the specified wake surface with a series of vortex quadrilateral panels on which a boundary condition of flow tangency is enforced. The vortex quadrilateral panel blockage model in Program JETPLT is based on a method developed by Maskew (reference 6).

The boundary of the jet wake, specified by the centerline path and the wake radius distribution along the centerline, is divided into length segments as illustrated in figure 9. Each

length segment is further divided into a number of circumferential segments. The number of axial and circumferential divisions and length of each segment are input by the user in Items 11 and 12. As with all finite panel methods, the representation of the flow around a solid body is better the further the point of interest is from the body. For practical problems of interest in this work; that is, flow around circular cross section jets with small diameters compared to their length, a good rule of thumb is that the point of interest should not be nearer to the surface than one panel width. It is also recommended for jets exhausting normal to the plate ($\theta = 0°$) that the panel lengths be equal to r_o or less for sections close to the jet exit and greater than r_o for sections farther from the jet exit.

As a jet is inclined from the normal to the plate, the shape of the jet exit at the plate becomes elliptical. In order to model this shape, modification of the panel layout in the region near the plate is necessary. Figure 11 shows a side view of the panel layout of a jet in the region near the plate for $V_j/V_\infty = 12.0$, $\theta = 45°$. The "transition" disc between the elliptical disc at the plate and the first circular disc is required to maintain panels of reasonable aspect ratio (height/width) in the front part of the jet. A disc, as indicated in the figure, is a slice through the jet cross-section at the end of a row of panels. The third disc and all remaining discs are circular.

Program JETPLT internally modifies the panel layout in the fashion just described; that is, an elliptical disc at the plate followed by a "transition" disc, and then a series of circular discs. To obtain accurate results, it is recommended for jets exhausting at an angle to the plate ($\theta > 0°$) that the first section into which the jet is divided (Items 11 and 12) contain two (2) segments (i.e., NDSI(1) = 2), each having a length equal to $r_o/2$ or less. Sections following the first section should have

length segments of the order r_o or larger. For example, correlation factors for all inclined jet cases were obtained using three (3) sections for the blockage model; section 1 consists of two segments, each of length $.4r_o$, section 2 consists of one segment of length r_o, and section 3 consists of seven segments, each of length $2.25r_o$.

Jet Entrainment Model

A jet exhausting from an infinite plate into a subsonic free stream will entrain air from the free stream and accelerate it in the direction of the jet. These effects are modeled in Program JETPLT using a modified version of an empirical method developed by Yeh (reference 4) in which the induced flow external to the jet boundary can be represented by sinks distributed along the jet axis.

The integral equations which define the velocities induced by the entrainment model do not have analytical solutions and must be solved numerically. This requires that a practical jet length be chosen to produce an accurate solution. Studies of the effect of jet length on the entrainment results showed a jet length of 20 initial jet radii to produce consistent results. Consequently, 20 initial jet radii is the upper integration limit for all predicted results and is the recommended centerline length for the jet.

Note that the entrainment model is applicable only for $V_j/V_\infty > 2.35$. At lower jet velocity ratios, empirically determined coefficients used in the model produce a singularity in the sink strength equation. This requires that NVEL = 2 in Item 5 for $V_j/V_\infty < 2.35$, which indicates that the blockage model only is required for this velocity ratio range.

Jet Spreading Rate

As a circular jet exhausts from an infinite plate into a subsonic crossflow velocity, the jet interaction with the free-stream velocity causes the boundary to expand or spread with increasing distance along the jet. Some knowledge of the extent of the jet boundary is important in predicting the displacement or blockage effect of the jet. The spreading rates used to obtain predicted pressures were obtained using a method which utilizes the empirical method of reference 7 and data from reference 8. This method assumes an axisymmetric jet with a potential core length of three jet diameters.

Figure 12 presents a series of expansion rate curves which show nondimensional jet radius (t/D) versus nondimensional distance along the jet centerline (S_a/R). These curves are used to represent the expansion of the circular cross section of the jet for specified values of V_j/V_∞ and θ.

Figure 13 presents plots of $(t/D)_{max}$ versus V_j/V_∞, where $(t/d)_{max}$ is the value of t/D at $S_a/R = 20$. As previously discussed, this value of jet centerline length (S_a/R) is used as the upper integration limit for the jet entrainment model and represents the total length of the jet. To obtain a spreading rate for arbitrary V_j/V_∞, the corresponding value of $(t/D)_{max}$ is obtained from figure 13 and is used to interpolate or extrapolate the curves shown in figure 12. Note that the expansion curves for $V_j/V_\infty = 10.0$ are used for $V_j/V_\infty = 12.0$. Also note that inclined jets should not be allowed to expand ahead of the position on the centerline where the normal to the centerline intersects the edge of the jet. This position is indicated in figures 12(b), (c), (d), and (e) on the t/D = 1.0 line. This prevents the blockage model from intersecting the plate and causing undue influence on plate field points near the jet.

SAMPLE CASES

In this section, several sample cases are presented to illustrate the preparation of input decks for various types of desired calculations. Samples Cases 1, 2, and 3 represent three basic types of calculations: i.e., (1) calculation of pressures due to the potential model only (correlation factors not included); (2) calculation of pressures, including correlation factors, at field points on the plate; and (3) calculation of normal-force and pitching-moment coefficients on a finite circular plate. All computation times given are for a VAX/VMS 11/780 machine.

The input deck for Sample Case 1, including corresponding item numbers, is shown in figure 14(a). This case is for a jet exhausting at an angle of $\theta = 60°$ with an initial jet-exit to free-stream velocity ratio of 8.0. Correlation factors are presently not available in Program JETPLT for these conditions; therefore, this calculation would be the first step in determining correlation factors for $V_j/V_\infty = 8.0$, $\theta = 60°$ if data were to become available. The jet centerline, given by equation (1) with $\delta_j = 30°$, is described using 22 points, and the jet spreading rate is obtained from figure 12(e). The blockage model is made up of three (3) major sections; section 1 with two segments of length .40 each, section 2 with one segment of length 1.0, and section 3 with seven segments of length 2.25 each. The jet cross-section is divided into 20 circumferential segments. Options are chosen to print out the quadrilateral panel corner and control points and the induced velocities from the blockage and entrainment models. Velocities and pressures are to be calculated at 133 field points, which are determined using seven (7) β values and nineteen (19) r/r_o values. Sample Case 1 requires approximately 200 seconds to execute.

The input deck for Sample Case 2 is shown in figure 14(b). This case is for a jet exhausting at $\theta = 15°$ with an initial

V_j/V_∞ = 3.9. This represents a typical case in which pressures, including the correlation factors, are calculated at plate field points. The jet centerline, given by equation (1) with δ_j = 75°, is described using 20 points, and the jet spreading rate is obtained from figure 12(b). The remainder of the input is identical to that described above for Sample Case 1. Sample Case 2 requires approximately 230 seconds to execute.

Sample Case 3, shown in figure 14(c), is included to illustrate a run to calculate the normal-force and pitching-moment coefficients on a finite circular plate. This case is for a jet exhausting normal to the plate (θ = 0°) with an initial V_j/V_∞ of 8.0. The centerline is given by equation (1) with δ_j = 90° and is described using 20 points. The spreading rate is obtained from figure 12(a). The field point layout is determined using a polar angle increment of 30° and five (5) radial positions. The finite plate has a radius of $11r_o$. The blockage model for this case consists of two major sections; section 1 with two segments of length 1.0 each and section 2 with eight segments of length 2.0 each. Options are specified to print a minimum quantity of output. Sample Case 3 requires approximately 150 seconds to execute.

OUTPUT DESCRIPTIONS

Typical sets of output from Program JETPLT are described in this section. In general, the output quantities are labeled and each page is headed with appropriate descriptive information. The actual output obtained is determined by the output options selected by the user. For purposes of this description, representative pages from Sample Cases 1, 2, and 3, described in a previous section, are presented in figures 15, 16, and 17.

The total output from Sample Case 1 is contained on 17 pages, including pages which are continuations of another page. The first page, shown in Figure 15(a), is headed by the title

cards input as Item 2. This is followed by jet input data and some calculated jet quantities, which include the effective V_j/V_∞, given by $(V_j/V_\infty)\cdot\cos\theta$, the jet circumference (P), distance along the jet centerline (SCL) and the local centerline inclination angle (THETA). The middle of this page contains the output and calculation options. The remainder of this page contains the entrainment model induced velocities at the first 23 plate field points. This output, which is obtained by setting NOUTD = 1 in Item 5, shows the coordinates of the field point (XB, YB, ZB), the components of velocity induced by the entrainment model (U/VO, U/VO, W/VO), and the total velocity ($VT/VO = \sqrt{(U/VO)^2 + (V/VO)^2 + (W/VO)^2}$). Pages 2 and 3, not shown in this figure, contain the entrainment induced velocities at the remainder of the plate field points (points 24 through 133).

The top of page 4, shown in figure 15(b), contains the blockage model input. This is followed by the coordinates of the quadrilateral panel corner points in the plate coordinate system. This output is obtained by setting NOUTA = 1 in Item 5. Pages 5 and 6, not shown in this figure, contain the coordinates of corner points 55 through 186. The top part of page 7, shown in figure 15(c), contains the coordinates of corner points 187 through 220. The bottom part of this page contains coordinates of the quadrilateral panel control points and the corresponding panel strengths. Pages 8, 9, and 10, not shown in this figure, contain the remainder of the list of control points and strengths. This output is obtained by setting NOUTB = 1 in Item 5.

The output contained on pages 11, 12, and the top part of 13, shown in figures 15(d), (e), and (f), is obtained by setting NOUTC = 1 in Item 5. These pages contain the velocity components induced by the blockage model (U/VO, V/VO, W/VO) at the plate field points (XCP, YCP, ZCP). The velocities and field points are in the plate coordinate system. The remainder of page 13 and

the following two pages shown in figures 15(g) and (h) contain the total jet induced velocities and the resulting pressure coefficients at the plate field points. Each line of the output contains the plate field point coordinate (XB, YB, ZB), the components of velocity due to the jet model and the free-stream velocity (V/V0, V/V0, W/V0), the total velocity (VT/V0), the pressure coefficient (CP), and the nondimensional radial position of the field point (R/D).

The final page of output, page 17 shown in figure 15(i), contains a message indicating that a correlation table does not exist for the combination of V_j/V_∞ and θ selected. Instructions for obtaining and setting up a correlation table using these predicted results are given in the section entitled CORRELATION FACTOR TABLES.

The total output from Sample Case 2 is contained on 19 pages. Page 1, which contains the title, jet geometry information, output and calculation options, and the first part of the list of entrainment model induced velocities, is shown in figure 16(a). Pages 2 through 15 contain output which is identical in format to that just described for Sample Case 1; therefore, this output is not shown in figure 16.

Pages 16, 17, and 18 shown in figures 16(b), (c), and (d) contain the predicted pressure coefficients, including correlation factors, at each plate field point. Following the title on page 16 is information identifying the initial jet-exit to free-stream velocity ratio and the initial inclination angle. Each of the columns below this information is labeled, but a brief explanation of the printed items follows. The first five columns, BETA, R/D, XB, YB, ZB, locate the field point in the plate coordinate system. The column CP,THEORETICAL is the pressure coefficient due to the jet model, DELTA CP is the correlation factor, and CP,CORRELATION is the resulting pressure coefficient and is equal to CP,THEORETICAL + DELTA CP.

The total output from Sample Case 3 is contained in four pages, shown in figure 17. The upper part of page 1, figure 17(a), contains the usual title and jet geometry information. This is followed by input data for the force and moment calculation, program-determined values of the r/D positions for these calculations, and output indicating the radius of the finite circular plate. The output and calculation options are printed at the bottom of page 1. Page 2, shown in figure 17(b), contains input data for the jet blockage model and the jet induced velocities and pressures at the plate field points. The field point layout for this case is shown in figure 18. The calculated pressure coefficients, including correlation factors, are shown on page 3, figure 17(c). The final page of output, page 4, is shown in figure 17(d) and contains the calculated force and moment information. Following the title on this page is information identifying the initial jet-exit to free-stream velocity ratio and the initial inclination angle. This information is followed by the plate area and the reference length. The final items on this page are (1) the normal-force coefficient, which is normalized by q_∞ and the plate area, and (2) the pitching-moment coefficient, which is normalized by q_∞, the plate area, and the indicated reference length. The positive senses of normal force and pitching moment are shown in figure 7(b).

PROGRAM LIMITATIONS

Program JETPLT is applicable to subsonic jets exhausting from a flat plate into a subsonic free stream. For jets exhausting normal to the plate, a large quantity of data are available, and the method is applicable to a wide range of jet velocity ratios. The method is not so complete for inclined jets due to the limited amount of available data for such cases. The major limitation of the program, therefore, is that correlation factors are not available for a wide range of jet velocity ratios for each jet inclination angle. Table I is provided to show the

combination of jet inclination angle and jet velocity ratio for which correlation tables presently exist. Another program limitation is that correlation factors are not always available for all combinations of r/D and β within a given table. This is due to a lack of data at various plate positions for certain combinations of θ and V_j/V_∞. In such cases, the correlation factor is given the value 99.0 in the table. These factors are used in the calculation of $(\Delta C_p)_{viscous}$; therefore, the user should ignore any predicted values of C_p greater than 1.0. The range of applicability of the program may be extended if additional data for inclined jets become available.

ERROR MESSAGES AND STOPS

The program code has internal error messages and several execution terminations at numbered STOP locations within the program. These are described in this section.

Most of the error messages in Program JETPLT are associated with the correlation tables. The first message is

VELOCITY RATIO IS OUTSIDE OF RANGE USED IN THE CORRELATION
FOR THETA = XXX.X DEGREES

This message, along with the value of θ, is printed when the jet velocity ratio of interest is outside the range available for the indicated inclination angle. This causes execution to terminate at STOP 11.

The second message is

INCLINATION ANGLE IS OUTSIDE OF RANGE USED IN THE CORRELATION

This message is printed when the inclination angle θ is greater than 60°, the maximum value of θ for which correlation tables exist. The causes execution to terminate at STOP 5.

The third message is

R(J) = X.XXXXX IS SMALLER THAN THE MINIMUM ALLOWED VALUE OF R/D = .75

This message, along with the value of R(J), is printed when the r/D position of a field point is less than .75. This causes execution to terminate at STOP 59.

The final message is:

***** MATRIX IS SINGULAR

This message is printed when the matrix used in the calculation of the center of curvature of the jet centerline is singular. This causes execution to terminate at STOP 16.

A summary of the program messages and their descriptions are given in the following table.

Termination Message	Description
STOP	Normal program stop
STOP 5	The initial inclination angle of interest is greater than 60°, which is the maximum value of θ for which correlation tables presently exist.
STOP 11	The jet-exit to free-stream velocity ratio is out of the range for the inclination angle of interest. This indicates that correlation factors cannot be obtained in the program for this case. Consult Table I to determine the range of jet velocity ratios for which correlation tables are available for each inclination angle, θ.

Termination Message	Description
STOP 16	The matrix used in the determination of the jet centerline center of curvature is singular. Check input description of jet centerline in Item 4.
STOP 59	The field point of interest has a r/D value less than .75. The range of r/D values for which correlation factors exist is .75 < r/D < 5.0. For values of r/D less than .75, the program terminates at STOP 59. For values of r/D greater than 5.0, the correlation factors are set equal to 0.0.

CORRELATION FACTOR TABLES

In the event that new pressure data become available, the present correlation factor tables may need to be updated and/or new correlation tables may need to be created. In order to make the necessary modifications to Program JETPLT, an understanding of how the correlation factors are stored and defined is required. This section is devoted to describing the correlation method, the present arrangement of the correlation factor tables and the procedure required to modify these tables or create new tables using new pressure data.

General Method

The purpose of the correlation is to isolate the viscous or nonpotential effects of the jet on the plate. Assuming that the measured pressure distribution can be represented by a potential part and a viscous part, the viscous part can be determined by a differencing technique.

$$\Delta C_p\Big|_{viscous} = C_p\Big|_{experiment} - C_p\Big|_{potential} \tag{3}$$

The potential portion of equation (3) is calculated using the Bernoulli equation in the following form:

$$C_p\Big|_{potential} = 1.0 - \frac{(V_\infty+u)^2 + v^2}{V_\infty^2} \qquad (4)$$

Correlating the quantity $\Delta C_p\big|_{viscous}$ as a function of jet velocity ratio and position on the plate, the predicted pressure induced by a jet exhausting from the plate into a crossflow is given by

$$C_p = C_p\Big|_{potential} + \Delta C_p\Big|_{viscous} \qquad (5)$$

In Program JETPLT, the initial jet inclination angle, θ, has been included, along with the jet velocity ratio, as a dominant parameter in determining pressures on the plate. This results in a data base which consists of a $(\Delta C_p)_{viscous}$ array as a function of β and r/D for each jet velocity ratio and jet inclination angle. Linear interpolation is used to determine correlation values at any V_j/V_∞, θ, β, and r/D values for which correlation values have not been determined.

Table Arrangement

The viscous correlation factors in Program JETPLT are defined in data statements in BLOCK DATA subroutine DELCP and are stored in two-dimensional arrays. These arrays are divided into groups, each of which corresponds to an initial jet inclination angle, as shown below.

Arrays	THETA, degrees
CPFIXA1 through CPFXA11	0
CPFIXB1 through CPFIXB9	15
CPFIXC1 through CPFIXC9	30
CPFIXD1 through DPFIXD6	45
CPFIXE1	60

Within a given group, each separate array corresponds to a jet-exit to free-stream velocity ratio. The number of V_j/V_∞ values and their actual values is different for each inclination angle, θ. For example, the corresponding V_j/V_∞ values for each of the arrays in the $\theta = 45°$ group are shown below. The V_j/V_∞ values for each inclination angle are given in DATA statement VJVO.

Array	V_j/V_∞
CPFIXD1 (I,J)	4.0
CPFIXD2 (I,J)	5.1
CPFIXD3 (I,J)	6.32
CPFIXD4 (I,J)	8.17
CPFIXD5 (I,J)	10.63
CPFIXD6 (I,J)	12.

The indices I,J associated with each array correspond to the polar angle, β, and the radial distance from the center of the jet, r/D, respectively. Program JETPLT is presently set up for seven (7) values of β (0°, 30°, 60°, 90°, 120°, 150°, 180°), six (6) values of r/D (.75, 1.0, 1.5, 2.0, 3.0, 5.0) and a maximum of eleven (11) values of V_j/V_∞ ($1.0 \leq V_j/V_\infty \leq 12.0$).

Each two-dimensional array contains the correction factors as a function of β and r/D for a given combination of jet inclination angle and jet exit velocity ratio. These arrays are

defined in data statements and are arranged in the following form:

β / r/D	0°	30°	60°	90°	120°	150°	180°
0.75	C(1,1)	C(2,1)	C(3,1)	C(4,1)	C(5,1)	C(6,1)	C(7,1)
1.0	C(1,2)	C(2,2)	C(3,2)	C(4,2)	C(5,2)	C(6,2)	C(7,2)
1.5	C(1,3)	C(2,3)	C(3,3)	C(4,3)	C(5,3)	C(6,3)	C(7,3)
2.0	C(1,4)	C(2,4)	C(3,4)	C(4,4)	C(5,4)	C(6,4)	C(7,4)
3.0	C(1,5)	C(2,5)	C(3,5)	C(4,5)	C(5,5)	C(6,5)	C(7,5)
5.0	C(1,6)	C(2,6)	C(3,6)	C(4,6)	C(5,6)	C(6,6)	C(7,6)

The jet inclination angle and jet-exit to free-stream velocity ratio corresponding to each two-dimensional array are indicated by comment cards in BLOCK DATA DELCP. For example, the correlation factors for $V_j/V_\infty = 5.0$, $\theta = 0°$ are found in BLOCK DATA DELCP under the main heading THETA = 0 DEGREES and the subheading VJ/VO = 5.0 and are contained in the array CPFIXA6.

```
DATA CPFIXA6/
1   -.146, -.034, -.256, -.918, -944, -2.038, -2.516
2   -.043, -.005, -.172, -.728, -1.082, -1.378, -1.705
3   -.020, .027 -.118, -.328, -.682, -.775, -952
4   .004, .050, -.072, -224 -.477, -.449, -.622
5   .015, .048, -.030, -.120, -.252, -.220, -.400
6   .012, .026 -.004, -.047, -.094, -.112, -.211/
```

The values of $(\Delta C_p)_{viscous}$ for r/D = .75 and β = 0° through 180° are given in line 1, the values for r/D = 1.0 are given in line 2, and so on.

To simplify the procedure for obtaining viscous correlation factors in subroutine FIX, three-dimensional arrays are equivalenced to the two-dimensional arrays in BLOCK DATA subroutine DELCP with each three-dimensional array corresponding to an initial jet inclination angle, as shown below.

Array	THETA, degrees
A (I,J,K)	0
B (I,J,K)	15
C (I,J,K)	30
D (I,J,K)	45
E (I,J,K)	60

The indices I, J, K associated with each array correspond to β, r/D, and the jet-exit to free-stream velocity ratio, V_j/V_∞, respectively. The EQUIVALENCE statements for the arrays associated with $\theta = 0°$ are shown below

```
 EQUIVALENCE (A(1,1,1),CPFIXA1(1,1)),(A(1,1,2),CPFIXA2(1,1)),
 1           (A(1,1,3),CPFIXA3(1,1)),(A(1,1,4),CPFIXA4(1,1)),
 2           (A(1,1,5),CPFIXA5(1,1)),(A(1,1,6),CPFIXA6(1,1)),
 3           (A(1,1,7),CPFIXA7(1,1)),(A(1,1,8),CPFIXA8(1,1)),
 4           (A(1,1,9),CPFIXA9(1,1)),(A(1,1,10), CPFXA10(1,1)),
 5           (A(1,1,11), CPFXA11(1,1)),
```

For each value of K, the three-dimensional array is equivalenced to a corresponding two-dimensional array containing the correlation factors for a particular value of V_j/V_∞. For example, the A(I,J,1) array is equivalenced to the CPFIXA1(I,J) array, which contains correlation factors for $\theta = 0°$, $V_j/V_\infty = 1.0$; the A(I,J,2) array is equivalenced to the CPFIXA2(I,J) array which contains factors for $\theta = 0°$, $V_j/V_\infty = 1.667$; and so on. A table of corresponding three-dimensional and two-dimensional arrays is shown below.

3-D Arrays	2-D Arrays	THETA, degrees
A(I,J,1)	CPFIXA1(I,J)	0
to	to	
A(I,J,11)	CPFXA11(I,J)	
B(I,J,1)	CPFIXB1(I,J)	15
to	to	
B(I,J,9)	CPFIXB9(I,J)	
C(I,J,1)	CPFIXC1(I,J)	30
to	to	
C(I,J,9)	CPFIXC9(I,J)	
D(I,J,1)	CPFIXD1(I,J)	45
to	to	
D(I,J,6)	CPFIXD6(I,J)	
E(I,J,1)	CPFIXE1(I,J)	60

DATA statements NSETS, which indicates the number of correlation tables (i.e., the number of V_j/V_∞ values) which exist for each θ angle, and VJVO, which includes the V_j/V_∞ values for which these correlation tables exist, are shown below.

```
      DATA VJVO/
     1          1.0,1.667,2.2,3.333,3.9,5.0,6.1,7.0,8.0,10.,12.,
     2          3.33,3.9,5.0,6.14,6.67,6.94,8.0,10.0,12.,99.,99.,
     3          3.33,4.0,5.1,6.36,6.67,8.15,10.0,10.87,12.,99.,99.,
     4          4.0,5.1,6.32,8.17,10.63,12.,99.,99.,99.,99.,99.,
     5          12.,99.,99.,99.,99.,99.,99.,99.,99.,99.,99./

      DATA NSETS/11,9,9,6,1/
```

NSETS indicates that there are eleven (11) V_j/V_∞ values (i.e., correlation tables) for $\theta = 0°$, nine (9) for $\theta = 15°$ and $30°$, six (6) for $\theta = 45°$, and one (1) for $\theta = 60°$. The values of the jet-exit to free-stream velocity ratios are shown in lines 1 through 5 in DATA statement VJVO for $\theta = 0°$, $15°$, $30°$, $45°$, and $60°$, respectively. Note that the number "99." in DATA statement VJVO is simply used to fill the VJVO array; these values are not used in the determination of correlation factors.

Modification Procedures

To modify a correlation table or to create a new one, it is first necessary to obtain theoretical pressures from the potential flow model. This requires modeling the jet for the conditions of interest (initial inclination angle, jet-exit to free-stream velocity ratio) as outlined in the INPUT DESCRIPTION and INPUT PREPARATION sections. The manner in which the correlation factors are defined, i.e., at specific β and r/D values, requires that theoretical pressures be calculated at plate field points corresponding to the β and r/D values given in BLOCK DATA DELCP. The theoretical and experimental pressures are used in conjunction with equation (3) to obtain $\Delta C_p\big|_{viscous}$ for each point. For the case in which a correlation factor table is being modified, the new ΔC_p values must be averaged with the original ΔC_p values to obtain the updated table. Such a modification does not require other changes in the program. For the case in which a new correlation table is being created, a variety of programming changes are required, and these are outlined below.

As an example, assume a new set of pressure data for $V_j/V_\infty = 8.0$, $\theta = 60°$ has been acquired. Only a single set of correlation factors presently exist for $\theta = 60°$; namely, those stored in array CPFIXE1 for $V_j/V_\infty = 12.0$. To add a new correlation factor table, all associated DATA, EQUIVALENCE, and DIMENSION statements and COMMON BLOCKS must be modified. First,

the last line of DATA statement VJVO, which includes the V_j/V_∞ values for which correlation tables exist for θ = 60°, and the last value in DATA statement NSETS, which indicates the number of correlation tables which exist for θ = 60°, are modified as shown below.

Original:

```
DATA VJVO/
1   1.0, 1.667, 2.2, 3.333, 3.9, 5.0, 6.1, 7.0, 8.0, 10., 12.,
2   3.33, 3.9, 5.0, 6.14, 6.67, 6.94, 8.0, 10.0, 12., 99., 99.,
3   3.33, 4.0, 5.1, 6.36, 6.67, 8.15, 10.0, 10.87, 12., 99.,
    99.,
4   4.0, 5.1, 6.32, 8.17, 10.63, 12., 99., 99., 99., 99., 99.,
5   12., 99., 99., 99., 99., 99., 99., 99., 99., 99., 99./

DATA NSETS/11,9,9,6,1/
```

Modified:

```
DATA VJVO/
1   1.0, 1.667, 2.2, 3.333, 3.9, 5.0, 6.1, 7.0, 8.0, 10., 12.,
2   3.33, 3.9, 5.0, 6.14, 6.67, 6.94, 8.0, 10.0, 12., 99., 99.,
3   3.33, 4.0, 5.1, 6.36, 6.67,8.15, 10.0, 10.87, 12., 99.,
    99.,
4   4.0, 5.1, 6.32, 8.17, 10.63, 12., 99., 99., 99., 99., 99.,
5   8., 12., 99., 99., 99., 99., 99., 99., 99., 99., 99./

DATA NSETS/11,9,9,6,2/
```

These changes indicate that two (2) correlation factor tables now exist for the θ = 60° case; one for V_j/V_∞ = 8.0 and the other for V_j/V_∞ = 12.0.

Adding a new correlation table also requires the addition of new two- and three-dimensional arrays in which the correlation factors are stored. The arrays CPFIXE1(I,J) and E(I,J,1) are presently used for $\theta = 60°$. Each three-dimensional array, i.e., E(I,J,K), is arranged such that V_j/V_∞ is monotonically increasing as the index K increases. In this manner, the K = 1 array contains correlation factors for the smallest V_j/V_∞ value, the K = 2 array for the next largest V_j/V_∞ value, and so on. In addition, the two-dimensional arrays are named such that the last two letters of each name indicate the corresponding three-dimensional array and its 'K' value. For example, CPFIX<u>A1</u>(I,J) corresponds to <u>A</u>(I,J,<u>1</u>), CPFIX<u>B2</u>(I,J) corresponds to <u>B</u>(I,J,<u>2</u>), etc. To maintain this consistency in naming arrays, the following modifications are made.

First, the array E(7,6,1) becomes E(7,6,2) in COMMON BLOCK FIXIT to allow storage of the new set of correlation factors for $\theta = 60°$, $V_j/V_\infty = 8.0$. Next, the correlation factors for $V_j/V_\infty = 8.0$ and $V_j/V_\infty = 12.0$ are stored in arrays CPFIXE1 and CPFIXE2, respectively. This requires changing the name of DATA statement CPFIXE1 to CPFIXE2 and adding a new DATA statement CPFIXE1 which contains the correlation factors for $\theta = 60°$, $V_j/V_\infty = 8.0$. The array CPFIXE2(7,6) is added to the DIMENSION statements, and an additional EQUIVALENCE statement; namely, EQUIVALENCE [E(1,1,2), CPFIXE2(1,1)] is required. In this manner, arrays CPFIXE1(I,J) and E(I,J,1) contain the correlation factors for $\Theta = 60°$, $V_j/V_\infty = 8.0$, and arrays CPFIXE2(I,J) and E(I,J,2) contain those for $\Theta = 60°$, $V_j/V_\infty = 12.0$. Note that the modification to COMMON BLOCK FIXIT must also be made in subroutine FIX.

PROGRAM JETBOD

GENERAL DESCRIPTION

The computer code, JETBOD, described in this section has application as an engineering prediction method for subsonic jets exhausting normally from the surface of a body at zero degrees angle of attack into a subsonic free stream (figure 19). This code, in conjunction with a panel code, provides a means to predict jet-induced pressures on a body in the vicinity of the jet. The methods incorporated in these codes are described in detail in reference 2.

The code consists of a main program, JETBOD, and 17 subroutines. The subroutine calling sequence for program JETBOD is shown in figure 20 where the general relationship between the subroutines and external references is illustrated. The main program, JETBOD, acts as an executive routine and directs the flow of the computation between the various program components. A cross reference table for the calling relationship between the program subroutines and the external references is shown in figure 21, and a similar table for the common blocks is shown in figure 22.

A modified version of the XYZ Potential Flow Program is used to model to the body geometry. This version is comprised of five separate programs; GENBOD, PFP1, PF2, PFP3, and PFP4. Details of the makeup and use of these programs is given in references 9 and 10.

The programs are written in standard FORTRAN language for use on a VAX 11/780 computer. Operation requires ten (10) logical units in addition to the usual input and output units. Execution time on the same computer for a typical case is of the

order of twenty (20) to thirty (30) minutes. Execution time depends on many factors such as the number of body panels, the number of points describing the jet centerline, and the number of panels used for the jet blockage model.

SUBROUTINE DESCRIPTIONS

The main program and the subroutines are briefly described in this section to provide a list of the contents of Program JETBOD.

JETBOD — Executive program for calculating (in conjunction with a panel code) the pressure distribution on a body of revolution induced by a jet exhausting from the body.

CLPT — Subroutine for setting up jet centerline quantities and their derivatives.

CNRPT — Executive routine for determining coordinates of corner points of quadrilateral panels.

DELCP — BLOCK DATA subroutine which contains the viscous correlation factors for a jet exhausting from a body of revolution. The factors are contained in data statements for jet-exit to free-stream velocity ratios 1.96 and 3.43 and are presented as a function of the axial distance from the jet center (x/D = -7.0, -5.9, -5.1, -4.2, -3.0, -2.0, -1.5, -1.0, 1.0, 1.5, 2.0, 3.0, 4.2, 5.1, 5.9, 7.0) and circumferential angle (PHI = 0, 1.25, 2.5, 3.75, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0, 22.5, 25.0 degrees).

ENTRAN — Subroutine to calculate entrainment model induced velocities at the body control points using the empirical method of Yeh (European Space Research Organization TT-159, May 1975).

FIX — Subroutine for obtaining the viscous correlation factors by interpolating in the tables presented in BLOCK DATA subroutine DELCP.

INRAD — Subroutine for determining radius of curvature and center of curvature of jet centerline.

INVER2 — Subroutine to solve simultaneous equations.

JET	Subroutine to input and print out jet parameters, jet centerline coordinates, and radius distribution.
JETBLK	Executive routine to input jet blockage model information and set up jet blockage model geometry.
JGEOM	Subroutine which organizes calls to various subroutines to obtain the jet blockage model geometry.
QCPQN	Subroutine for determining coordinates of control points on each quadrilateral panel.
SADIF	Subroutine for determining XCLR and ZCLR centerline coordinates corresponding to centerline distance S0 by interpolating in the jet centerline coordinate table.
SIMP1	Simpson Rule integration routine.
SINTGX	Function used in conjunction with a Simpson Rule integration routine to calculate the x-component of velocity induced at the body control points by the jet entrainment model.
SINTGY	Function used in conjunction with a Simpson Rule integration routine to caluclate the y-component of velocity induced at the body control points by the jet entrainment model.
SINTGZ	Function used in conjunction with a Simpson Rule integration routine to calculate the z-component of velocity induced at the body control points by the jet entrainment model.
TMXSR	Subroutine for determining coordinates of corner points of each quadrilateral panel.

INPUT DESCRIPTION

The purpose of this section is to describe the input to program JETBOD and to the various programs comprising the panel code. The input formats for program JETBOD are shown in figure 23. The input descriptions for the five programs making up the panel code follow that for Program JETBOD and are shown in figures 24 through 26. The definitions of the individual variables are provided in the following paragraphs. The order follows that shown in figures 23 through 26 where the input format for

each item and the location of each variable on each card is presented. Data input in I-format are right justified in the fields and data input in F-format may be placed anywhere in the field and must include a decimal point. Note that many length parameters in the input list are dimensional variables; therefore, special care must be taken that all lengths and areas are input in a consistent set of units.

Provided at the end of this section are instructions for setting up input for the jet centerline shape, spreading rate, and blockage model. Also included are instructions for modeling the body from which the jet is exhausting. These instructions coupled with a sample case in a later section make it simple for the user to set up the input for a typical case of a jet exhausting from a body into a crossflow.

Program JETBOD

Item 1 is a single card containing three integers, each right justified in a five-column field.

Item	Variable	Description
1	NHEAD	number of header cards to be input in Item 2
	NJET	number of jets (NJET=1)
	NFIX	=1, field point coordinates and associated pressure coefficients (calculated in panel code) are input via unit 25, and $(\Delta C_p)_{viscous}$ correlation factors are added to the pressure coefficients
		=0, calculate jet entrainment model induced velocities at body control points (NVEL = 1 in Item 5) or determine jet blockage model geometry (NVEL = 2 in Item 5)

Item 2 is a series of NHEAD cards containing hollerith information identifying the run. The information is reproduced in the output just as it is input.

Item	Variable	Description
2	TITLE	NHEAD lines of information to be printed at the top of the first page of output

Items 3 and 4 contain jet geometry information. Item 3 is a single card and Item 4 is a set of NCYL(J) cards. The body and jet coordinate systems are shown in figure 19 and information regarding jet centerline shape and jet spreading rate is given following this section.

Omit Items 3 and 4 if NFIX = 1

Item	Variable	Description
3	GAM(J)	ratio of jet-exit to free-stream velocity
	XO(J), YO(J), ZO(J)	coordinates of the origin of the jet in the body coordinate system, figure 19
	THETA(J,1)	inclination angle of jet at exit plane, measured in the plane of free-stream flow, deg; THETA(J,1) = 0.0
	NCYL(J)	number of entries in centerline table describing the jet in Item 4
4	XCLR(J,N), YCLR(J,N), ZCLR(J,N)	coordinates of the jet centerline in jet coordinate system
	AJET(J,N)	dimensional radius of jet along the centerline

Item 5 is a single card containing the jet exit radius, and is included only if NFIX = 1. Omit Item 5 if NFIX = 0.

Item	Variable	Description
5	AJET(J,1)	jet exit radius, dimensional

Items 6 is a single card containing the number of body control points and input, output, and calculation options.

Item	Variable	Description
6	NP	number of body control points at which jet entrainment model induced velocities or viscous correlation factors are to be calculated
	NVEL	velocity calculation options: =1, entrainment model velocity calculation only =2, blockage model corner points stored on unit 1
	NSAVE	=1, jet entrainment model induced velocities stored on unit 10 =0, above quantities not saved
	NOUTA	=1, output quadrilateral panel corner points =0, above quantities not output
	NOUTB	=1, output quadrilateral panel control points =0, above quantities not output
	NOUTD	=1, output individual entrainment model induced velocities =0, above quantities not output
	NFPTS	field point input option: =0, input control point coordinates via unit 5 =1, input control point coordinates via unit 3
	NCPBOD	=0, all jet-induced velocities calculated by prediction method =N, velocities at "N" blockage model control points are set equal to zero

Item 7 is a set of NP cards, each of which contains the coordinates of a body control point in the body coordinate system. In the version of the panel code used here, these coordinates are calculated in the panel code, written to unit 3, and are input to program JETBOD via unit 3 (NFPTS = 1 in Item 5).

Omit Item 7 if NFIX = 1 or NP = 0.

Item	Variable	Description
7	XP(J), YP(J), ZP(J)	body control points at which jet entrainment model induced velocities are to be calculated

Item 8 contains the body control points and the corresponding pressure coefficients calculated in the panel code. This information in written to unit 25 in the panel code and is input to program JETBOD via this same unit. Item 8 is included only when NFIX = 1 in Item 1.

Omit Item 8 if NFIX = 0 or NP = 0.

Item	Variable	Description
8	XP(J), YP(J), ZP(J), CP(J)	body control points and corresponding pressure coefficients calculated in panel code

Item 9 is a single card containing the number of the first and last blockage model control points. The entrainment model induced velocities (NVEL = 1) are set equal to 0.0 at these points.

Omit Item 9 if NCPBOD = 0 or NVEL = 2.

Item	Variable	Description
9	NFRST NLAST	first and last blockage model control points at which jet entrainment model induced velocities are to be specified

Items 10 and 11 contain input for the jet blockage model. The jet is divided along its axis into NDS major sections, each of which is divided into NDSI segments (see figure 9). The blockage model panels each subtend an angle of 360/NPHI degrees and the orientation of the front panel with respect to the free-stream direction is given by PHIO. It is recommended that PHIO be set equal to 0°. The dimensional panel length (along the jet axis) for each segment within a given section is given by DSI. It is recommended that NDS, NDSI, and DSI be such that the length of blockage model is about the same as the length of the jet as given by the jet centerline input (Item 4). It is also recommended that DSI be equal to r_o (jet exit radius) or less for sections close to the jet exit and greater than r_o for sections farther from the jet exit.

Omit Items 10 and 11 if NVEL = 1 or NFIX = 1.

Item	Variable	Description
10	NPHI(NJ)	number of circumferential segments into which jet cross-section is divided
	NDS(NJ)	number of major sections along jet centerline into which the jet is divided ($1 \leq NDS \leq 5$)
	NDSI(NJ,NK)	number of segments along jet centerline into which each section is divided; NK = 1, NDS(NJ)
11	PHIO(NJ)	orientation angle of front panel, 0° recommended
	DSI(NJ,NK)	panel length (longitudinal) of the segments within each section; NK = 1, NDS(NJ)

Program GENBOD

Item 1 is a single card containing one integer right justified in a five-column field.

Item	Variable	Description
1	NHEAD	number of header cards to be input in Item 2

Item 2 is a series of NHEAD cards containing hollerith information identifying the run. This information is reproduced in the output just as it is input.

Item	Variable	Description
2	TITLE	NHEAD lines of information to be printed at the top of the first page of output

Items 3 through 11 contain information for determining body panels which are used to model the body shape. Refer to reference 9 and to the section entitled INPUT PREPARATION for instructions on laying out panels to model the body. Item 3 is a single card containing two integers, each right justified in a five column field.

Item	Variable	Description
3	NSECT5	number of body sections on the body of revolution, information to be input via unit 5
	NSECT1	=1, jet blockage model corner points are input via unit 1

Items 4 through 9 are repeated for each body section (i.e., NSECT5 number of times).

Item	Variable	Description
4	NXSTAT	number of axial stations in the given section
	NEXTRA	number of extra corner points input via unit 5
	VN	normal component of velocity at the body surface, VN = 0.0

Items 5 though 8 are repeated NXSTAT times.

Item	Variable	Description
5	NEWTH	=0, θ distribution for this axial station is the same as that for the previous axial station
		=1, new θ distribution to be input in Items 6, 7, and 8
	NI	axial station index
	XN, RN	x coordinate (in body coordinate system, see figure 19) and body radius at given axial station

Items 6, 7, and 8 contain information for specifying the circumferential angle (θ) distribution for the given body section. The angle θ is equal to 0° along the positive z-axis with a positive rotation in the negative y-axis direction.

Omit Items 6, 7, and 8 if NEWTH = 0.

Item	Variable	Description
6	NTHET	=0, input θ (circumferential angle) information in Item 7
		=1, number of θ values input in Item 8
	MSTART	starting M-index for corners calculated from this θ distribution

Omit Item 7 if NTHET > 0.

Item	Variable	Description
7	THFRST	starting value of θ, degrees
	THLAST	final value of θ, degrees
	DELTH	θ increment, degrees

Omit Item 8 if NTHET = 0.

Item	Variable	Description
8	THET(I)	specified values for Θ, degrees (I = 1, NTHET)

Item 9 is a set of NEXTRA cards. Omit Item 9 if NEXTRA = 0.

Item	Variable	Description
9	NI, MI	axial and circumferential corner indices
	X,Y,Z	panel corner coordinates in body coordinate system

Items 10 and 11 are repeated NSECT1 times and are input via unit 1. This input contains jet blockage model corner point information as determined in Program JETBOD.

Omit Items 10 and 11 if NSECT1 = 0

Item	Variable	Description
10	NPTS	number of points to be input in Item 11
11	X(J),Y(J), Z(J)	jet blockage model corner coordinates in body coordinate system
	NI,MI	axial and circumferential panel indices for the given corner coordinate

Item 12 contains flow condition information. Program JETBOD will presently handle zero angle of attack only.

Item	Variable	Description
12	VXI, VYI, VZI	components of the first onset flow in the body coordinate system ($u/V_\infty, v/V_\infty, w/V_\infty$); VXI = -1.0, VYI = 0.0, VZI = 0.0

Program PFP1

Item 1 is a single card containing hollerith information identifying the run.

Item	Variable	Description
1	TITLE	single line of information to be printed at the top of the first page of output

Item 2 contains parameters pertaining to the body geometry and flow conditions, and input and output options.

Item	Variable	Description
2	NQE	number of quadrilateral elements to be specified by the point cards. The maximum value permitted for NQE is 650.
	NSE	number of sections used
	MIX	maximum number of iterations to be performed for the x flow. A smaller number of iterations will be performed if the convergence test is passed
	MIY	maximum number of iterations for the y flow
	MIZ	maximum number of iterations for the z flow
	ISM	number of planes of symmetry =0, indicates there are no planes of symmetry =1, indicates that y=0 is a plane of symmetry =2, indicates that y=0 and z=0 are planes of symmetry =3, indicates that y=0, z=0, and x=0 are planes of symmetry
	EPS	convergence criteria used in testing the convergence of the iterations. (EPS = .0001)

Item	Variable	Description
	IUCT	centroid indicator. If IUCT > 0, the centroid is used in place of the null point. If IUCT = 0, the null point is used.
	IPS IPF ISP	not used in this version of the program. Set IPS = 0, IPF = 0, and ISP = 0
	IEDIT1	print option for Program PFP1 =0, information for all quadilateral corner points is output =1, above output is suppressed =2, above output is printed only for quadilaterals with associated warning messages
	IEDIT3	print option for Program PFP3 =0, output convergence information for each interation =1, output convergence information for last iteration only
	IEDIT4	print option for Program PFP4 =0, output for the three basic flows is printed =1, above output is suppressed, output for extra flows is printed.
	ITAPE	corner point input option =0, panel corner point information (Item 3) and additional flows are input via unit 5 =1, panel corner point information and first additional flow input via unit 50
	XCENTR YCENTR ZCENTR	reference point (in body coordinate system) from which solid angle is calculated

Item 3 is a set of NQE cards, each containing information for a corner point on the body (and jet blockage model) surface. This information is input via unit 50 if ITAPE = 1. Note that all point cards for one section must be together, but within the section they may be input in any order.

Item	Variable	Description
3	XI,YI,ZI	x-, y-, and z-coordinate of the corner point in the body coordinate system
	NI	N index of the point. NI < 71
	MI	M index of the point. MI < 41
	NS	Section identification number. Any positive integer from 1 to 9999 may be used. In general each section should have a unique section number. However, two sections can have the same number if they are separated by another section.
	NE	Change indicator for the direction of the normal vector. When NE on the first card of a section is not blank or zero, NI and MI are interchanged for that section to change the direction of the normal vector. On other cards NE is ignored.
	VN	Normal component of the velocity at the body surface, VN = 0.0 for the problem of interest. The value of VN from the first card in a section is used for the entire section.

Item 4 contains up to 18 additional flows, each given by the components of the free-stream velocity. Item 4 is replaced with a blank card in this version of PFP1.

Item	Variable	Description
4	VXI,VYI,YZI	components of free-stream flow (u/V_∞, v/V_∞, w/V_∞), to be replaced with a blank card in this version of PFP1

Program PF2

There is no required user-supplied input to Program PF2. Geometry information (determined in PFP1) is read from units 3 and 4 and is used to calculate the influence coefficient matrix for the body panels.

Program PFP3

Item 1 is a single card containing two integers, each right justified in a four column field.

Item	Variable	Description
1	IJET	=1, jet entrainment model induced velocities at body control points are input via unit 10
	IEDIT3	print option =0, output convergence information for each iteration =1, output convergence information for last iteration only

Program PFP4

Item 1 contains input, output, and calculation options.

Item	Variable	Description
1	IJET	=1, jet entrainment model induced velocities are input via unit 10
	IEDIT4	print option =0, output for the three basic flows is printed =1, above output is suppressed, output for extra flows is printed
	IFLOW	>0, calculate velocities and pressures for additional flows to be input in Item 2 =0, velocities and pressures are calculated for the three basic flows
	IFORCE	not used in this version of Program PFP4, set IFORCE = 0

Omit Item 2 if IFLOW = 0.

Item	Variable	Description
2	U(I),V(I), W(I)	components of free-stream velocity for each additional onset flow

INPUT PREPARATION

In this section, the individual flow models of the jet model are described briefly and instructions on correctly specifying input for each of the models are given. The previous section on the input description must be used to understand the individual variables which go into JETBOD, and this section will permit the user to select the appropriate input to achieve maximum success with the code. Also included are some notes on modeling the body of revolution.

Jet Centerline Model

The path of the jet centerline is specified using an empirical relation developed by Viehweger (reference 11). This relation, obtained by correlating results for a low pressure jet with a short potential core exhausting from a body of revolution, is written as

$$x_j/D = 1.727(z_j/D \quad \sqrt{q_\infty/q_j})^{2.65} \tag{6}$$

For practical purposes, the assumption is made that $\sqrt{q_\infty/q_j}$ is approximately equal to V_∞/V_j. Figure 27 shows centerline shapes for velocity ratios 1.96 and 3.43 as given by equation (6).

Jet Blockage Model

Blockage effects of the jet were obtained by modeling the jet surface as an integral part of the body of revolution model. In this manner, the mutual interference effects between the jet surface and the body are accounted for simultaneously. With respect to the panel layout in the region of the body/jet intersection, the edges of the body panels are matched to the edges of the jet surface panels, thereby providing a smooth transition from the cylinder surface to the jet surface.

Jet Entrainment Model

Jet entrainment effects are modeled using the empirical method of Yeh, which is described in detail in reference 4. Although this method was developed for a jet exhausting from a flat plate, lack of an available entrainment model for a jet exhausting from a body of revolution necessitated the use of a flat plate model. The entrainment-induced velocities are included with the jet blockage model induced velocities in the boundary condition on the body surface. The entrainment induced velocities are not included in the boundary conditions on the jet surface. Refer to the discussion of the entrainment model for the flat plate case for details concerning input preparation.

Jet Spreading Rate

The spreading rate for a jet exhausting from a body of revolution is calculated using the same method used for the flat plate (see previous discussion for flat plate model). Once again, lack of spreading rate data or theory for a jet exhausting from a body of revolution necessitated the use of a flat plate method.

A series of expansion rate curves corresponding to a potential core length of 1.5 jet diameters is shown in figure 28. The $V_j/V_\infty = 1.96$ and 3.43 curves were obtained by extrapolating the $V_j/V_\infty = 4$, 6, and 8 expansion curves using information from figure 29. This figures present $(t/D)_{max}$ versus V_j/V_∞ where $(t/D)_{max}$ is the value of t/D at $S_a/R = 20$. This curve is utilized in the same fashion as outlined in the section on jets exhausting from a flat plate.

Body of Revolution Model

The panel code used to model the body of revolution geometry (reference 9 and 10) approximates the surface of the body by a

set of plane quadrilaterals. Certain restrictions which apply to the manner in which these quadrilaterals are arranged on the body are noted in this section.

The quadrilaterals are organized in groups of four about a common corner point as shown in figure 30; therefore, there must be an even number of quadrilaterals in both the N and M directions in each of the sections of the body. Corner point numbering for quadrilaterals 1, 2, 3, and 4 is also shown in figure 30.

The sides between quadrilaterals are used to define the quadrilateral coordinate systems and serve as the axis of rotation when the surface is flattened to facilitate the numerical differentiation of the velocity. Thus, the common corner point of a group of four quadrilaterals must not coincide with any other corner point. A third restriction is that each set of four quadrilaterals must have at least seven distinct corner points to allow a curved surface to be fitted to the points; therefore, only two of the four quadrilaterals may degenerate into triangles by having two of their corner points coincide.

The last restriction also is a result of the way the curved surface is fitted to the points. The angle between the normal vectors of two quadrilaterals in a group of four must be less than 90° and preferably less than 45°. If a sharp edge is required the input should be arranged so that the edge is along the boundary of the groups of four and not through the center.

CALCULATION PROCEDURE

The pressure distribution induced on a body of revolution by a jet issuing normally from the surface of the body is obtained using Program JETBOD in conjunction with a modified version of the XYZ Potential Flow Code. Program JETBOD is used to obtain the jet blockage model corner points and the jet entrainment model induced velocities, and to add the viscous correlation

factors to pressure coefficients calculated by the potential flow code. The XYZ Potential Flow Code is used to generate the body of revolution geometry, to combine the body and jet geometries, and to calculate potential pressure coefficients at the body control points. Program JETBOD and the various programs making up the potential flow code are run in sequence with information passed from one program to another via logical units. The basic calculation procedure is shown in figure 31 and is described in detail below.

The first step in the calculation procedure is the calculation of the jet blockage model corner points in Program JETBOD. For this calculation, the user sets NVEL = 2 in order for the corner points to be written to unit 1 and NP = 0 to bypass the field point input. The usual centerline and blockage model input are included for this calculation. Next, Program GENBOD is used to generate the body of revolution geometry and to combine the body geometry with the jet blockage model geometry. The blockage model corner points are input via unit 1 by setting NSECT1 = 1 in Item 3 of the GENBOD input. The panel corner points of the entire configuration are written to unit 50. These points are read from unit 50 in Program PFP1 by setting ITAPE = 1 in Item 2. In this program, the configuration control points are calculated and written to unit 3.

Program JETBOD is used next to calculate jet entrainment model induced velocities at the configuration control points, which are read from unit 3 by setting NFPTS = 1 in Item 6. For this calculation, NFRST and NLAST, input in Item 9, are required so that induced velocities are not calculated at blockage model control points. Also, NSAVE = 1 (Item 6) is required to write the jet-induced velocities to unit 10. Next, geometry information determined in Program PFP1 is read from units 3 and 4 in Program PF2 and is used to obtain the influence coefficient

matrix for the configuration panels. There is no required user-supplied input for Program PF2.

The source distribution over the entire configuration is obtained in Program PFP3 using control point information read from unit 3 and jet entrainment model induced velocities read from unit 10. The source distribution information and jet-induced velocities are passed to Program PFP4 and are used to obtain velocities and pressure coefficients at all body control points. The user is required to set IJET = 1 in both Program PFP3 and PFP4 to input velocities via unit 10. The control points and the associated pressure coefficients are written to unit 25. This information is read in Program JETBOD from this same unit by setting NFIX = 1 in Item 1, and the viscous correlation factors are added to the predicted pressures to obtain the corrected pressure coefficients. The centerline description input (Item 4) and the blockage model input (Items 10 and 11) are not required for this calculation.

A special note is made here with respect to the jet entrainment model. Due to a singularity in the entrainment model equation for $V_j/V_\infty < 2.35$ (see Jet Entrainment Model section for the flat plate), entrainment model induced velocities at body control points are not calculated for this velocity ratio range. In such cases Program JETBOD is not run following Program PFP1, and the user must set IJET = 0 in Program PFP3 and PFP4. Program JETBOD is then run after Program PFP4 in the same manner as described above.

SAMPLE CASE

In this section, a sample case is presented to illustrate the preparation of input decks for Program JETBOD and the various programs making up the potential flow code. The sample case is for a jet with $V_j/V_\infty = 3.43$ exhausting from the cone-cylinder

configuration of reference 12, shown in figure 32. The configuration is modeled using a symmetry option of the potential flow code, which necessitated modeling only one-half of the jet/body combination. A total of 632 panels are used to model the configuration; 532 panels on the body and 100 panels on the jet surface. The jet is divided into 20 circumferential segments (10 segments per half plane) with panels near the body having an aspect ratio (height/width) of 3.18. A fine grid on the body is utilized in the region of the jet in order to get better resolution of the pressures in that region.

The input decks for the sample case are shown in figure 33. The input deck for the first step in the calculation procedure, i.e., the calculation of the jet blockage model corner points in Program JETBOD, is shown in figure 33(a). The jet centerline, given by equation (6) with $\sqrt{q_j/q_\infty} = 3.43$, is described using 24 points, and the jet spreading rate is obtained from figure 28. The blockage model is made up of two major sections; section 1 with two segments of length .32 each, and section 2 with eight segments of length .64 each. Options to print out the blockage model corner points and to write these points to unit 1 are chosen.

The input deck for Program GENBOD is shown in figures 33(b) and (c). The body is divided into four (4) major sections; the cone nose, the cylinder ahead of the jet, the cylinder in the region of the jet, and the cylinder aft of the jet (see figure 32). Information for laying out panels on the body is input via unit 5 and the option to read the jet blockage model corner points from unit 1 is chosen.

The input deck for Program PFP1, shown in figure 33(d), indicates that the total configuration is modeled in five (5) sections using 632 panels. A maximum of 150 iterations are to be performed in the determination of the panel source strengths in

Program PFP3. Options to use the symmetry option of the potential flow code and to input the configuration panel corner points via unit 50 are chosen. The option to print corner point information for all quadrilaterals is chosen also.

Figure 33(e) contains the input deck for calculating the jet entrainment model induced velocities in Program JETBOD. The jet centerline description is identical to that shown in figure 33(a). Options are chosen to input configuration control points via unit 3, to print out the jet entrainment model induced velocities and to write these velocitites to unit 10, and to set these velocities to zero at the jet blockage model control points. Jet blockage model information is not input for this run.

Figures 33(f) and (g), each consisting of a single card, contain the input decks for Programs PFP3 and PFP4, respectively. In both decks, IJET = 1 indicates that the jet entrainment model induced velocities are input via unit 10. Figure 33(h) contains the final set of input for Program JETBOD. The option to read the body control points and their associated pressure coefficients from unit 25 and to add the viscous correlation factors to these pressure coefficients is chosen. The jet centerline description and the blockage model information are not required for this run; however, the initial jet radius is input in Item 5. Note that the number of control points indicated is for the body only.

OUTPUT DESCRIPTION

A typical set of output for the case of a jet exhausting from a body of revolution is described in this section. In general, the output quantities are labeled and each is headed with appropriate descriptive information. The actual output obtained is determined by the output options selected by the user. The total output from the sample case, described in a previous section, is contained in eight separate sets of output; three sets

from Program JETBOD, and one set each from Programs GENBOD, PFP1, PF2, PFP3, and PFP4. For purposes of this description, representative pages from each of these sets of output are presented in figures 34 through 41.

The total output from the calculation of the jet blockage model corner points in Program JETBOD is contained on five pages, including pages which are continuations of another page. The first page, shown in figure 34(a), is headed by the title cards input as Item 2. This is followed by jet input data and some calculated jet quantities, which include the jet circumference (P), distance along the jet centerline (SCL), and the local centerline inclination angle (THETA). The middle of this page contains the output, input, and calculation options. The top of page 2, shown in figure 34(b), contains the blockage model input. This is followed by the coordinates of the quadrilateral panel corner points in the body coordinate system. This output, shown in figures 34(b) through (e), is obtained by setting NOUTA = 1 in Item 6.

The output from Program GENBOD is contained on 13 pages. At the top of the first page of output, shown in figure 35(a), are the title cards input as Item 2. The remainder of this page and most of the following page [figure 35(b)] contain the body geometry information for Section 1. Information for each section includes the axial location, body radius, circumferential angles, and index data as input by the user, and the calculated coordinates for each point. The bottom part of figure 35(b) contains the first part of the geometry information for Section 2. Pages 3 through 6, not shown in this figure, contain the remainder of body geometry information for Section 2 and for most of Section 3. The top and middle of page 7, shown in figure 35(c), contain the last part of the typical geometry information for Section 3 and the additional points input as Item 9. This output is followed at the bottom of page 7 by the first part of the geometry

output for Section 4. The last part of the output for Section 4 is on page 11, figure 35(d), and is followed at the bottom of this page and on pages 12 and 13 [figures 35(e) and (f)] by the input data for Section 5.

The output from Program PFP1 is contained on 58 pages. The first page, shown in figure 36(a), is headed by identification from the program and the title card input by the user as Item 1. The remainder of this page contains input data. Page 2, figure 36(b), contains geometry information for the quadrilaterals containing control points 1 through 10. Column 1 contains the indices and point number identifying the quadrilateral. Columns 2 through 5 locate the corner points of the quadrilateral in the body coordinate system, and column 6 indicates the coordinates of the quadrilateral centroid. The variables in the remaining columns, which are of little interest here, are described in reference 9 and 10. Geometry information for all quadrilaterals is printed by setting IEDIT1 = 0 in Item 2. Note that the warning message 'LONG THIN QUAD' can result from a point that is out of position but is in the plane of the quadrilateral. In this case, the quadrilaterals on the cone nose meet the criteria for this message to be printed even though the points describing the nose are not in error; therefore, this message should be ignored here.

The last page containing quadrilateral information, page 57, is shown in figure 36(c), and contains information for quadrilaterals representing the jet surface. The message 'INWARD NORMAL' is printed if a normal vector points toward the origin. For a point on the body surface, this message could indicate a quadrilateral that has been defined incorrectly; however, for a point on the jet surface, this message should be ignored since the normals for many quadrilaterals on this surface are indeed pointing toward the origin. The last page of output for Program PFP1, page 58, is shown in figure 36(d) and contains the flow

vector input as Item 12 in Program GENBOD. The value of the solid angle shown on this page should be approximately equal to 4π.

The total output from the calculation of jet entrainment model induced velocities in Progrm JETBOD is contained on 12 pages. The first page, shown in figure 37(a), contains information identical to that described above for the blockage model calculation. The bottom of page 1, all of page 2, and the top of page 3 contain the configuration control points at which the jet induced velocities are set to zero. These points are input by the user in Item 9 and represent the quadrilaterals which model the jet surface. The remainder of page 3, shown in figure 37(c), contains the entrainment model induced velocities at body control points. This output shows the coordinates of the control points (XB,YB,ZB), the components of velocity induced by the entrainment model (U/VO,V/VO,W/VO), the total velocity ($VT/VO = \sqrt{(U/VO)^2 + (V/VO)^2 + (W/VO)^2}$) , and the axial position (X/D) and circumferential location (PHI, in degrees) of the control points. Pages 4 through 12 of the output, not shown in figure 37, contain similar output for the remaining configuration control points.

The output from Program PF2 consists of a single page, shown in figure 38, and contains program identification and the title card input as Item 1 in Program PFP1.

The total output from Program PFP3 is contained on 12 pages. Page 1, shown in figure 39(a), contains program identification, the title card input as Item 1 in Program PFP1, and the input and print options. Page 2, figure 39(b), shows a partial list of the jet induced velocities at configuration control points which are input via unit 10 from Program JETBOD. The end of this list is shown at the top of page 11, figure 39(c). The remainder of page 11 and all of page 12, shown in figure 39(d), contain information about the convergence of the iterations for

computing the source density. A description of this output can be found in reference 9 and 10.

The total output from Program PFP4 is contained on 53 pages. Page 1, shown in figure 40(a), contains program identification, the title card input as Item 1 in Program PFP1, and the input, print, and calculation options. Page 2, figure 40(b), is the first page of output for the X-flow, and contains the coordinates of the control point, the components of velocity and total velocity at that point, the resulting pressure coefficient, and the panel source strength and normal velocity at the control point. The remainder of the output for the X-flow and similar output for the Y- and Z-flows, not shown in figure 40, are contained on pages 3 through 40. Ths output is obtained by setting IEDIT4 = 0 in Item 1. Similar output for the additional flow input as Item 12 in Program PFP1 is contained on pages 41 through 53. Page 41 is shown in figure 40(c). Although the option to print output for all of the flows was chosen for this case, it is recommended that output for the additional flow only be obtained by setting IEDIT4 = 1 in Item 1.

The final set of output for the sample case is from Program JETBOD and is contained on 10 pages. Page 1, shown in figure 41(a), contains run identification input as Item 2, input, output, and calculation options, and jet parameters. The jet centerline description and blockage model information are not required input for this run and are therefore not printed here. Page 2, shown in figure 41(b), contains the predicted pressure coefficients, including viscous correlation factors, at body control points. Following the title on page 2 is information identifying the jet-exit to free-stream velocity ratio. Each of the columns below this information is labeled, but a brief explanation of the printed items follows. The first six columns, J, X, Y, Z, X/D, PHI locate the control point in the body coordinate system. The column CP,THEORETICAL is the pressure

coefficient calculated in the potential flow code, DELTA CP is the correlation factor obtained in Program JETBOD, and CP,CORRELATION is the resulting pressure coefficient and is equal to CP,THEORETICAL + DELTA CP. Pages 3 through 10, not shown in figure 41, contain the same information for the remaining body control points.

PROGRAM LIMITATIONS

Program JETBOD was developed (reference 2) using pressure data from reference 12, which was at that time the only available source of pressure data for a jet exhausting froma body of revolution. Due to the lack of available data, the present method is limited to jet velocity ratios less than 4.0 and jet-to-body diameter ratios less than 0.1. The method is also limited to jets exhausting normal from the body surface. Additional data are needed to extend the method to higher jet velocity ratios and to larger jet-to-body diameter ratios typical of full-scale fan-in-fuselage configurations.

ERROR MESSAGES AND STOPS

The JETBOD code has internal error messages and two execution terminations at numbered STOP locations within the program. These are described in this section.

The most common message in Program JETBOD is:

VELOCITY RATIO IS OUTSIDE OF RANGE USED IN THE CORRELATION

This message is printed when the jet-exit to free-stream velocity ratio is less than 1.96 or greater than 3.43. This causes execution to terminate at STOP 11.

The other message in the program is:

***** MATRIX IS SINGULAR

This message is printed when the matrix used in the calculation of the center of curvature of the jet centerline is singular. This cause execution to terminate at STOP 16.

A summary of the program messages and their descriptions are given in the following table:

Termination Message	Description
STOP 1	Normal program stop for calculation of jet blockage model corner points
STOP 2	Normal program stop for calculation of jet entrainment model induced velocities
STOP 3	Normal program stop for determination of viscous correlation factors
STOP 11	The jet-exit to free-stream velocity ratio is less than 1.96 or greater than 3.43. Correlation tables are not available for velocity ratios outside of this range.
STOP 16	The matrix used in the determination of the jet centerline center of curvature is singular. Check input description of jet centerline in Item 4.

CORRELATION FACTOR TABLES

In order to make the necessary modifications to Program JETBOD to include new correlation factor tables, an understanding of how the correlation factors are stored and defined is required. This section is devoted to describing the present arrangement of the correlation factor tables and the procedure required to modify these tables or create new ones using new pressure data.

General Method

The purpose of the correlation for the body of revolution case is the same as that for the flat plate case; that is, to isolate the viscous or nonpotential effects of the jet on the body. Equations (3) and (5), which apply to the flat plate correlaton, are also applicable to the body of revolution correlation.

In a manner similar to that done for the flat plate case, $(\Delta C_p)_{viscous}$ values are obtained by comparing theoretical pressure coefficients from the potential flow code with experimental data at chosen ϕ and x/D stations for each V_j/V_∞. A data base is set up which consists of a $(\Delta C_p)_{viscous}$ array for each jet velocity ratio. Linear interpolation is used to determine the correlation factor at any V_j/V_∞, ϕ, and x/D values for which correlation curves have not been determined.

Table Arrangement

The viscous correlation factors in Program JETBOD are defined in data statements in BLOCK DATA subroutine DELCP and are stored in two-dimensional arrays. These arrays are divided into groups, each of which corresponds to a jet-exit to free-stream velocity ratio. Within each group, each separate array contains correlation factors for a specific range of circumferential angles. The various arrays and the corresponding jet-exit to free-stream velocity ratio and range of the circumferential angle, ϕ, are shown below.

Array	V_j/V_∞	ϕ range, degrees
CPFIX1A(I,J)	1.96	0 to 7.5
CPFIX1B(I,J)	1.96	10 to 25
CPFIX2A(I,J)	3.43	0 to 7.5
CPFIX2B(I,J)	3.43	10 to 25

The indices I,J associated with each array correspond to the axial distance from the center of the jet, x/D, and the circumferential angle, ϕ, respectively. Program JETBOD is presently set up for sixteen (16) values of x/D (±7, ±5.9, ±5.1, ± 4.2, ±3, ±2, ±1.5, ±1), thirteen (13) values of ϕ (0, 1.25, 2.5, 3.75, 5.0, 7.5, 10., 12.5, 15.,0, 17.5, 20., 22.5, 25. degrees), and two velocity ratios (1.96, 3.43). Each two-dimensional array contains the correlation factors as a function of x/D and ϕ. These arrays are defined in data statements and are arranged as shown in Table II. The jet-exit to free-stream velocity ratio and the ϕ range corresponding to each two-dimensional array are indicated by comment cards in BLOCK DATA DELCP. For example, the correlation factors for V_j/V_∞ = 1.96 for the range ϕ = 10° to 25° are found in BLOCK DATA DELCP under the heading

VJ/VO = 1.96, PHI = 10., 12.5,, 15., 17.5, 20., 22.5, 25.

and are contained in the array CPFIX1B, shown below.

```
    VJ/VO = 1.96 , PHI = 10.,12.5,15.,17.5,20.,22.5,25.

 DATA CPFIX1B/
1-.008,0.,-.011,-.037,-.122,-.232,-.25,-.136,.023,.015,.003,-.003,
2.019,.030,.033,.010,
3-.004,.003,-.007,-.027,-.091,-.135,-.13,-.06,.035,.02,.012,.006,
4.023,.020,.035,.010,
5-.003,.005,-.005,-.024,-.068,-.087,-.083,-.027,.032,.019,.007,
6.013,.021,.026,.034,.011,
7-.005,0.,-.005,-.015,-.045,-.05,-.055,-.01,.03,.025,.017,.02,.025,
8.03,.035,.01,
90.,.005,.005,-.018,-.035,-.02,-.035,0.,.02,.03,.025,.023,.025,.03,
1.035,.008,
20.,.005,.005,-.013,-.025,-.015,-.018,.006,.02,.035,.022,.025,
3.029,.033,.035,.008,
40.,.005,.008,-.01,-.015,-.01,0.,.012,.015,.035,.02,.028,.03,
5.035,.035,.01/
```

The values of $(\Delta C_p)_{viscous}$ for $\phi = 10°$ and x/D = -7.0 to +7.0 are given in lines 1 and 2, the values for $\phi = 12.5°$ are given in lines 3 and 4, and so on.

In a manner similar to that done for the flat plate case, a three-dimensional array is equivalenced to the two-dimensional arrays in BLOCK DATA DELCP to simplify the procedure for obtaining viscous correlation factors. The three-dimensional array and the corresponding V_j/V_∞ values are shown below.

Array	V_j/V_∞
A(I,J,1)	1.96
A(I,J,2)	3.43

The indices I,J,K associated with this array correspond to x/D, ϕ, and the V_j/V_∞ value. Due to the manner in which the two-dimensional arrays are arranged, the A array for J = 1 to 6 (ϕ = 0° to 7.5°) is equivalenced to the first two-dimensional array in each group, and the A array for J = 7 to 13 (ϕ = 10° to 25°) is equivalenced to the second, as shown below.

```
      EQUIVALENCE (A(1,1,1),CPFIX1A(1,1)),(A(1,1,2),CPFIX2A(1,1)),
     1            (A(1,7,1),CPFIX1B(1,1)),(A(1,7,2),CPFIX2B(1,1))
```

Modification Procedures

To modify a correlation table or to create a new one, it is first necessary to obtain theoretical pressures from the potential flow model. This requires modeling the jet for the jet-exit to free-stream velocity ratio of interest as outlined in the

INPUT DESCRIPTION and INPUT PREPARATION sections. The manner in which the correlation factors are defined, i.e., at specific x/D and ϕ values, requires that theoretical pressures be calculated at plate field points corresponding to the ϕ and x/D values given in BLOCK DATA DELCP. The theoretical and experimental pressures are used in conjunction with equation (3) to obtain $\Delta C_p\big|_{viscous}$ for each point. For the case in which a correlation factor table is being modified, the new ΔC_p values must be averaged with the original ΔC_p values to obtain the updated table. Such a modification does not require other changes in the program. For the case in which a new correlation table is being created, several programming changes are required, and these are outlined below.

As an example, assume a new set of pressure data for $V_j/V_\infty = 2.5$ has been acquired. Correlation factor tables presently do not exist for this jet velocity ratio; therefore, new correlation tables must be created. As mentioned for the flat plate case, addition of a correlation factor table requires modification of all associated DATA, EQUIVALENCE, and DIMENSION statements and COMMON BLOCKS. First, the last value in DATA statement NSETS, which indicates the number of correlation tables (i.e., V_j/V_∞ values), is changed from 2 to 3. The new V_j/V_∞ value is then added to DATA statement VJVO such that the V_j/V_∞ values are arranged in a monotonically increasing order. The original and modified statements are shown below.

Original:

```
DATA VJVO/1.96,3.43/
DATA NSETS/16,13,2/
```

Modified:

```
DATA VJVO/1.96,2.5,3.43/
DATA NSETS/16,13,3/
```

These changes indicate that correlation factor tables now exist for three (3) jet velocity ratios; namely V_j/V_∞ = 1.96, 2.5, and 3.43.

Addition of new correlation tables in Program JETBOD also requires the addition of new two-dimensional arrays and modification of the three-dimensional array in which the correlation factors are stored. The arrays CPFIX3A(I,J) and CPIX3B(I,J) are logical choices for new arrays in this case, since CPFIX1A and CPFIX1B are presently used for V_j/V_∞ = 1.96 and CPFIX2A and CPFIX2B are used for V_j/V_∞ = 3.43. The three-dimensional array A(I,J,K) is arranged such that the K = 1 array contains correlation factors for the smallest V_j/V_∞ value, the K = 2 array for the next largest V_j/V_∞, and so on. In addition, the two-dimensional arrays are named such that the number associated with the array corresponds to the "K" value of the A(I,J,K) array. For example, CPFIX<u>1</u>A and CPFIX<u>1</u>B correspond to the A(I,J,<u>1</u>) array. To maintain this consistency in naming arrays, the following modifications are made.

First, the array A(16,13,2) becomes A(16,13,3) in COMMON BLOCK FIXIT to allow storage of the new set of correlation factors for V_j/V_∞ = 2.50. Next, the correlation factors for V_j/V_∞ = 2.50 are stored in arrays CPFIX2A and CPFIX2B and those for V_j/V_∞ = 3.43 are stored in arrays CPFIX3A and CPFIX3B. This requires changing the names of DATA statements CPFIX2A and CPFIX2B to CPFIX3A and CPFIX3B, respectively, and adding new DATA statements CPFIX2A and CPFIX2B which contain the correlation factors for V_j/V_∞ = 2.50. The arrays CPFIX3A(16,6) and CPFIX3B(16,7) are added to the DIMENSION statements and additional EQUIVALENCE statements, namely,

EQUIVALENCE (A(1,1,3), CPFIX3A(1,1)), (A(1,7,3), CPFIX3B(1,1))

are required. Note that the modification to COMMON BLOCK FIXIT must also be made in subroutine FIX.

REFERENCES

1. Perkins, S. C., Jr. and Mendenhall, M. R.: A Correlation Method to Predict the Surface Pressure Distribution on an Infinite Plate from Which a Jet is Issuing. NASA CR-152160, May 1978.

2. Perkins, S. C., Jr. and Mendenhall, M. R.: A Correlation Method to Predict the Surface Pressure Distribution on a Infinite Plate or a Body of Revolution From Which a Jet is Issuing. NASA CR-152345, May 1980.

3. Margason, R. J.: The Path of a Jet Directed at Large Angles to a Subsonic Free Stream. NASA TN D-4919, November 1968.

4. Yeh, B. T.: Calculation of the Pressure Distribution Induced by a Jet on a Flat Plate. ESRO-TT-159, May 1975.

5. Chang, H. S. and Werner, J. E.: Analysis of an Entrainment Model of the Jet in a Crossflow. NASA CR-132324, November 1972.

6. Maskew, B.: Calculation of the Three-Dimensional Potential Flow Around Lifting Nonplanar Wings and Wing-Bodies using a Surface Distribution of Quadrilateral Vortex Rings. Report TT-7009, Loughborough University of Technology, September 1970.

7. Bowley, W. W. and Sucec, J.: Trajectory and Spreading of a Turbulent Jet in the Presence of a Crossflow of Arbitrary Velocity Distribution. Presented at 14th Annual Gas Turbine Conference and Products Show, ASME Paper 69-GT-33, March 1969.

8. Keffer, J. F. and Baines, W. D.: The Round Turbulent Jet in a Cross-Wind. Journal of Fluid Mechanics, Vol. 15, Pt. 4, April 1963, pp. 481-497.

9. Dawson, C. W. and Dean, J. S.: The XYZ Potential Flow Program. NSRDC Report 3892, June 1972.

10. Dawson, C. W. and Dean, J. S.: The Calculation of Streamline Data for Boundary Layer Input. NSRDC Report CMD-7-74, January 1974.

11. Viehweger, G.: Flow Effects with Cross-Blown Lifting Jets of V/STOL Aircraft and their Reaction on Aerodynamical Forces and Moments of the Nacelle. NASA TM-75143, July 1976.

12. Ousterhout, D. S.: An Experimental Investigation of a Cold Jet Emitting from a Body of Revolution into a Subsonic Free Stream. NASA CR-2089, August 1972.

Table I. CORRELATION FACTOR TABLE INFORMATION FOR PROGRAM JETPLT

Initial Inclination Angle, Deg.	Jet-Exit of Free-Stream Velocity Ratio
0°	1.0, 1.667, 2.2, 3.33, 3.8, 5.0, 6.1, 7.0, 8.0, 10.0, 12.0
15°	3.33, 3.9, 5.0, 6.14, 6.67, 6.94, 8.0, 10.1, 12.0
30°	3.33, 4.0, 5.1, 6.36, 6.67, 8.15, 10.0, 10.87, 12.0
45°	4.0, 5.1, 6.32, 8.17, 10.63, 12.10
60°	12.0

Table II. STORAGE ARRANGEMENT FOR CORRELATION FACTORS IN PROGRAM JETBOD

ϕ \ X/D	-7.0	-5.9	-5.1	-4.2	-3.0	-2.0	-1.5	-1.0	1.0	1.5	2.0	3.0	4.2	5.1	5.9	7.0
0°	CA(1,1)	CA(2,1)	CA(3,1)	CA(4,1)	CA(5,1)	CA(6,1)	CA(7,1)	CA(8,1)	CA(9,1)	CA(10,1)	CA(11,1)	CA(12,1)	CA(13,1)	CA(14,1)	CA(15,1)	CA(16,1)
1.25°	CA(1,2)	CA(2,2)														CA(16,2)
2.5°	CA(1,3)		CA(3,3)													CA(16,3)
3.75°	CA(1,4)			CA(4,4)												CA(16,4)
5.0°	CA(1,5)				CA(5,5)											CA(16,5)
7.5°	CA(1,6)	CA(2,6)	CA(3,6)	CA(4,6)	CA(5,6)	CA(6,6)	CA(7,6)	CA(8,6)	CA(9,6)	CA(10,6)	CA(11,6)	CA(12,6)	CA(13,6)	CA(14,6)	CA(15,6)	CA(16,6)
10°	CB(1,1)	CB(2,1)	CB(3,1)	CB(4,1)	CB(5,1)	CB(6,1)	CB(7,1)	CB(8,1)	CB(9,1)	CB(10,1)	CB(11,1)	CB(12,1)	CB(13,1)	CB(14,1)	CB(15,1)	CB(16,1)
12.5°	CB(1,2)	CB(2,2)														CB(16,2)
15°	CB(1,3)		CB(3,3)													CB(16,3)
17.5°	CB(1,4)			CB(4,4)												CB(16,4)
20°	CB(1,5)				CB(5,5)											CB(16,5)
22.5°	CB(1,6)					CB(6,6)										CB(16,6)
25°	CB(1,7)	CB(2,7)	CB(3,7)	CB(4,7)	CB(5,7)	CB(6,7)	CB(7,7)	CB(8,7)	CB(9,7)	CB(10,7)	CB(11,7)	CB(12,7)	CB(13,7)	CB(14,7)	CB(15,7)	CB(16,7)

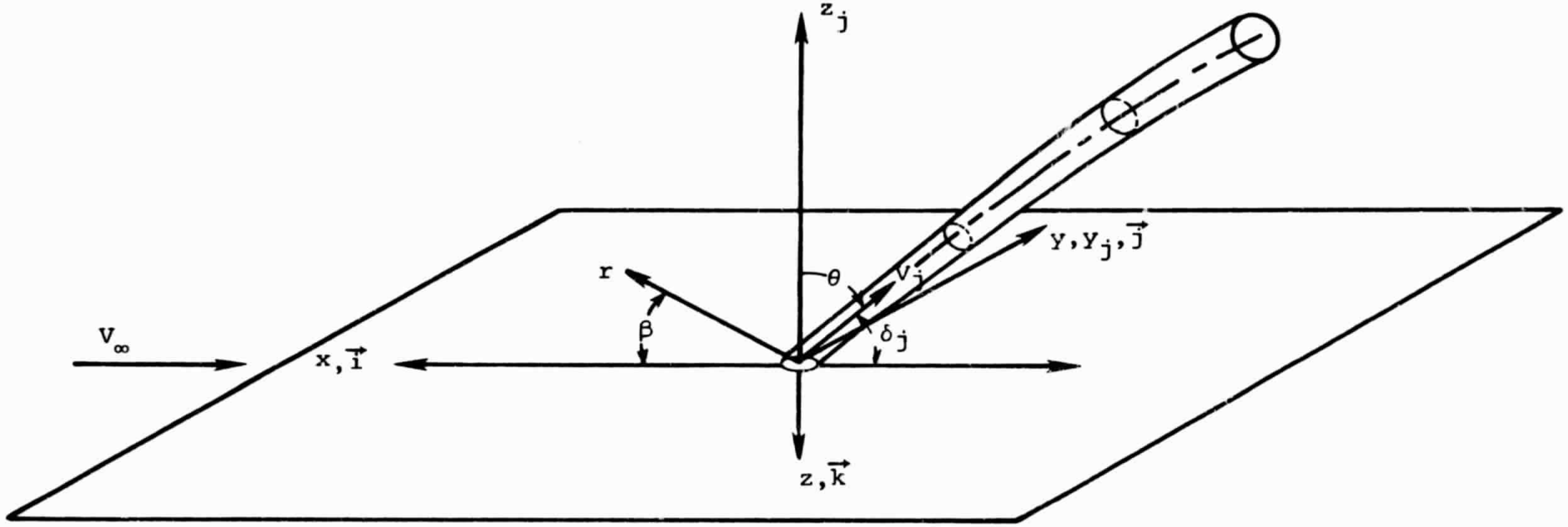


Figure 1.- Coordinate system for a jet issuing from a flat plate into a subsonic crossflow (isometric view).

```
PROGRAM
JETPLT

    |--JET
    |--FORCE
    |--ENTRAN  ----SINTGX  ----SADIF
    |             |--SINTGY  ----SADIF
    |             |--SIMP1   ----FUN
    |--JETBLK  ----UINF
    |             |--JGEOM   ----CLPT
    |                           |--INRAD   ----INVER2
    |                           |--CNRPT   ----TMXSR
    |                           |--QCPQN
    |                           |--PDIST
    |                           |--QVC
    |                           |--GAMSLV
    |                           |--INVER2
    |--JETVIN  ----PDIST
    |             |--QVC
    |--FIX

PROGRAM
  END
```

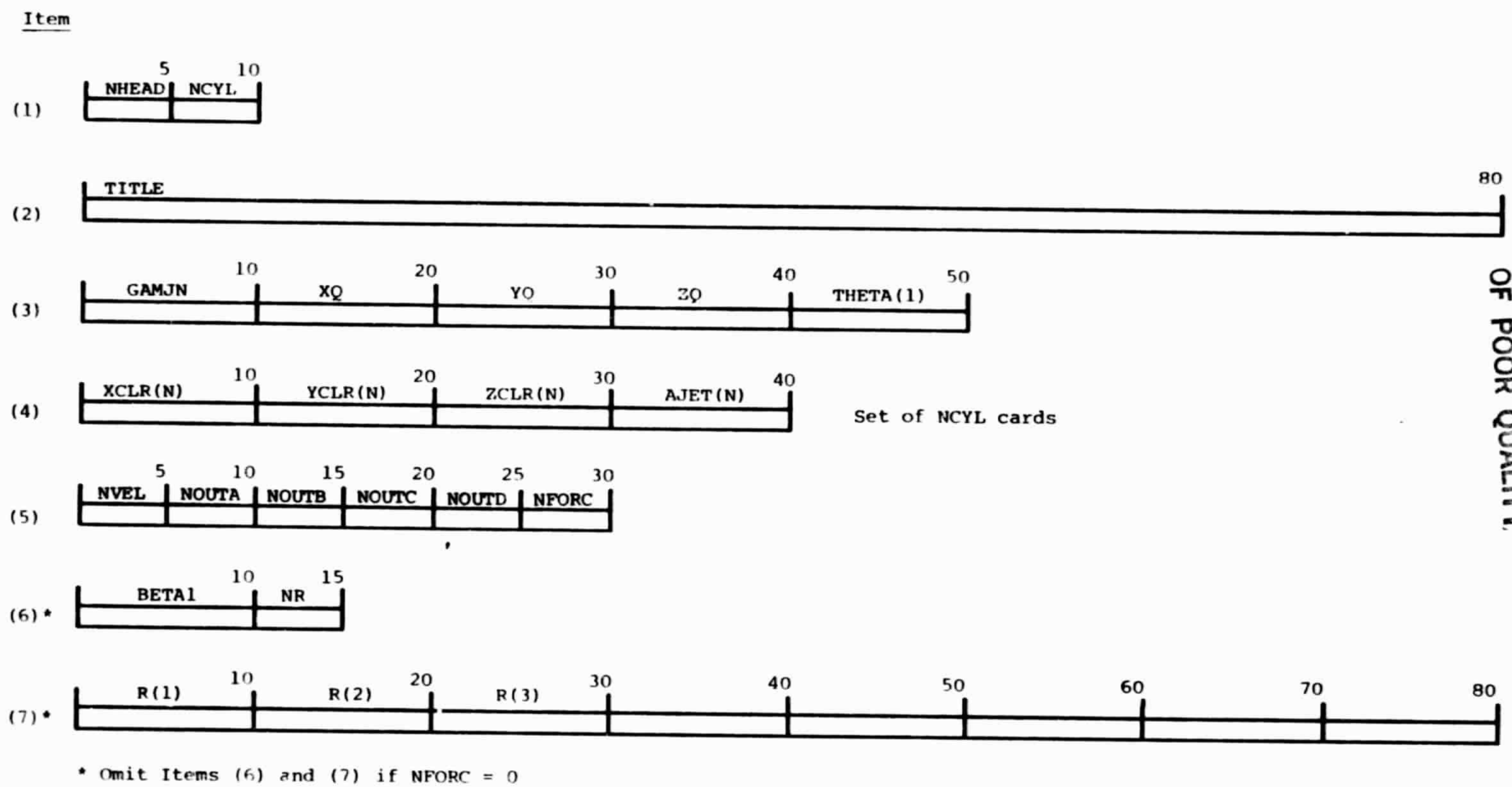
Figure 2.- Subroutine calling sequence for Program JETPLT.

SUBROUTINE NAME / EXTERNAL REFERENCES	CLPT	CNRPT	DELCP	ENTRAN	FIX	FORCE	GAMSLV	INRAD	INVER2	JET	JETBLK	JETPLT	JETVIN	JGEOM	PDIST	QCPQN	QVC	SADIF	SIMP1	SINTGX	SINTGY	TMXSR	UINF
CLPT														X									
CNRPT														X									
ENTRAN												X											
FIX												X											
FORCE												X											
FUN																			X				
GAMSLV														X									
INRAD														X									
INVER2								X						X									
JET												X											
JETBLK												X											
JETVIN												X											
JGEOM											X												
PDIST													X	X									
QCPQN														X									
QVC													X	X									
SADIF																				X	X		
SIMP1				X																			
SINTGX				X																			
SINTGY				X																			
TMXSP		X																					
UINF											X												

Figure 3.- Subroutine cross reference table for Program JETPLT.

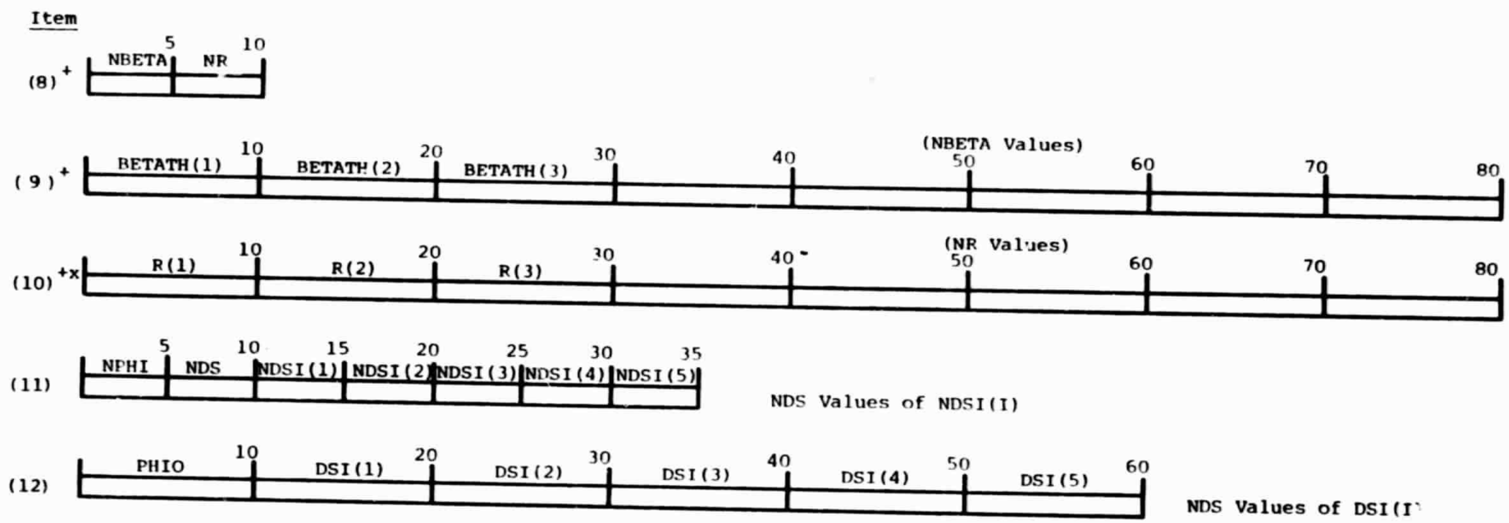
SUBROUTINE NAME / COMMON BLOCKS	CLPT	CNRPT	DELCP	ENTRAN	FIX	FORCE	GAMSLU	INRAD	INVER2	JET	JETBLK	JETPLT	JETVIN	JGEOM	PDIST	QCPON	QVC	SADIF	SIMP1	SINTGX	SINTGY	TMXSR	UINF
ANGLD		X									X					X	X					X	
CLDATA	X	X						X														X	
CLDIM		X									X												
CONST		X		X		X				X	X	X										X	
EXP						X						X											
FIXIT			X		X																		
FORC						X						X											
IMAGE												X			X		X						
INFLMT							X	X						X									
MATX		X																				X	
NDEX							X				X		X	X	X	X						X	
NOPT						X				X	X	X											
ODROT4		X					X				X		X	X	X	X	X					X	
UJIND											X	X	X										
VINF							X				X												X
XYZCL	X	X		X				X		X	X	X			X							X	
YEH				X														X		X	X		

Figure 4 .- Common block cross reference table for Program JETPLT.



(a) Page 1

Figure 5.- Input forms for program JETPLT.



+Omit Items (8), (9) and (10) if NFORC = 1

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(b) Page 2

Figure 5.- Concluded.

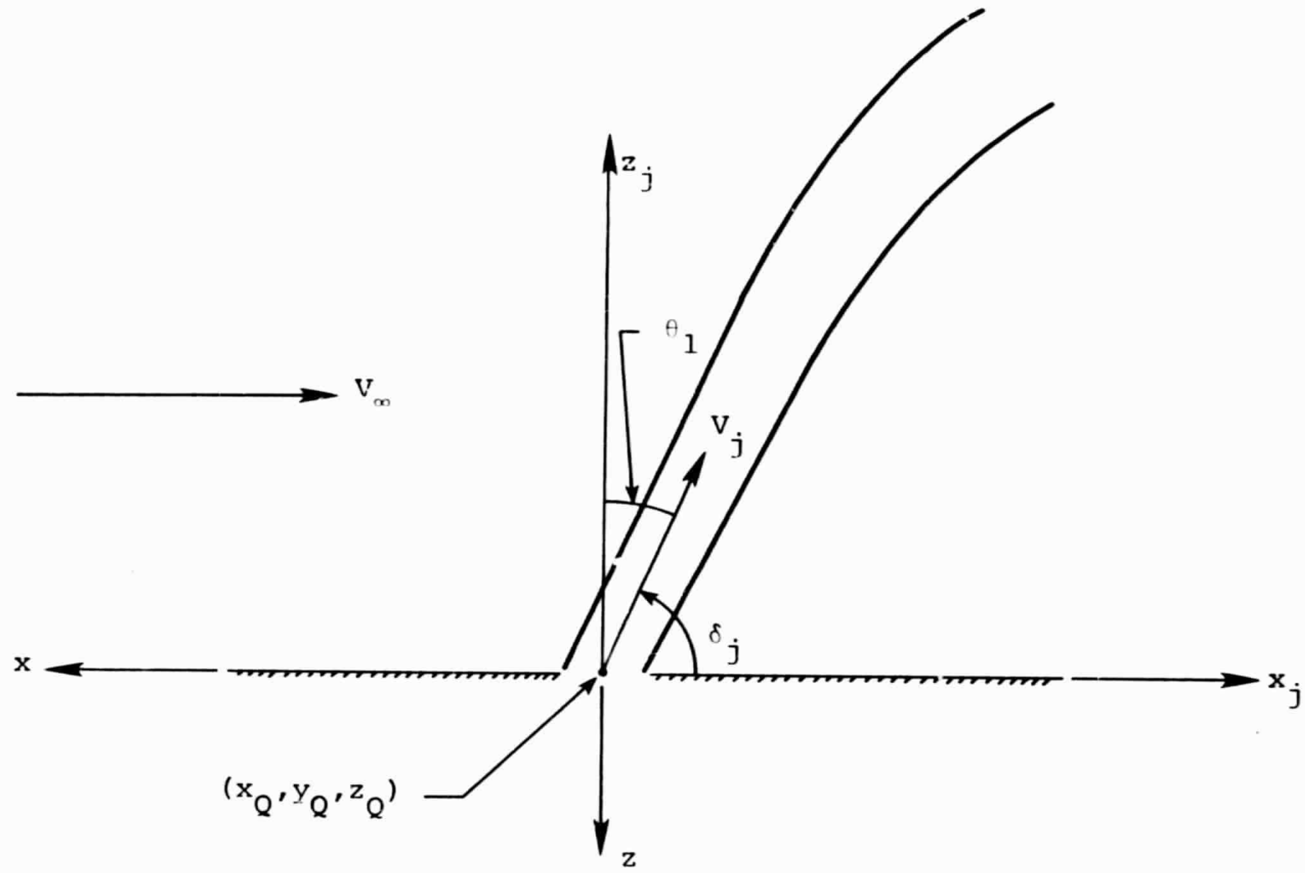
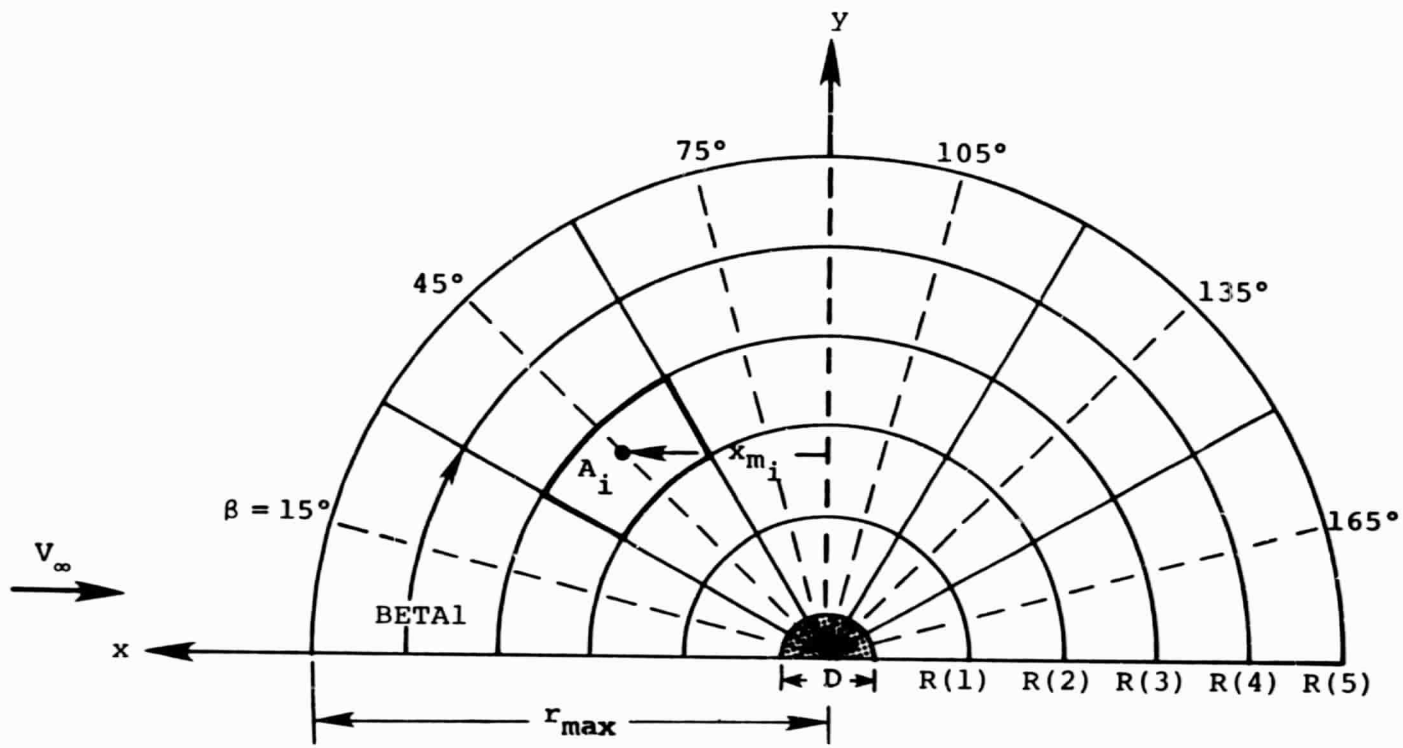
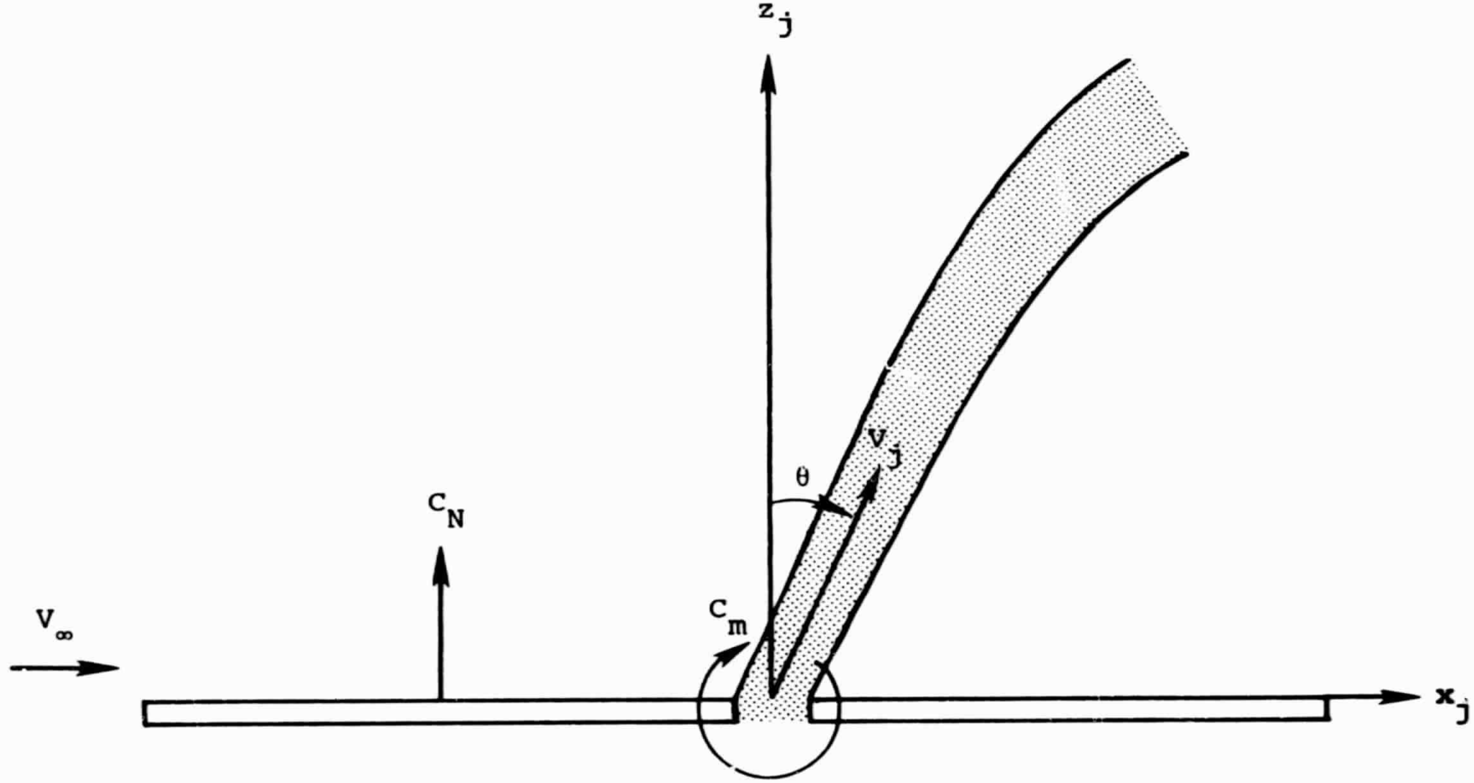


Figure 6.- Side view of jet/plate system showing plate and jet coordinate systems.



(a) Typical grid layout.

Figure 7.- Finite circular plate.



(b) Force and pitching moment nomenclature.

Figure 7 .- Concluded.

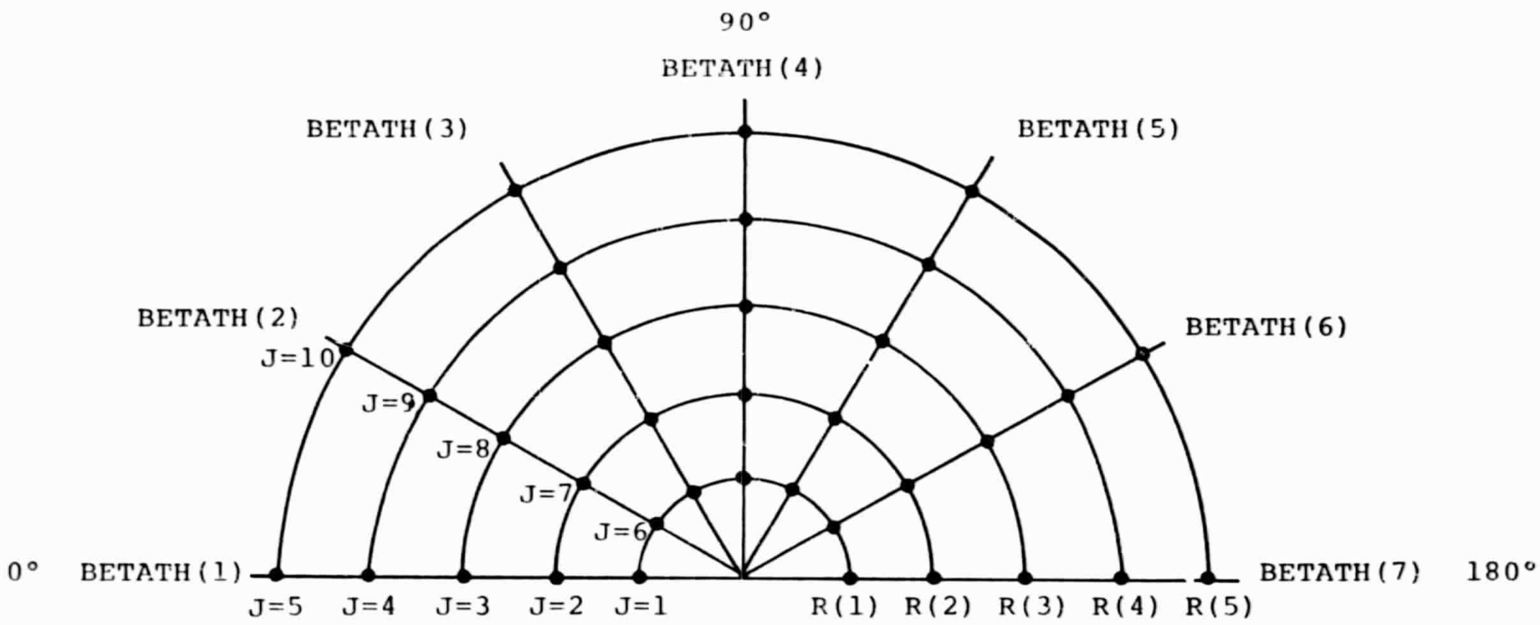
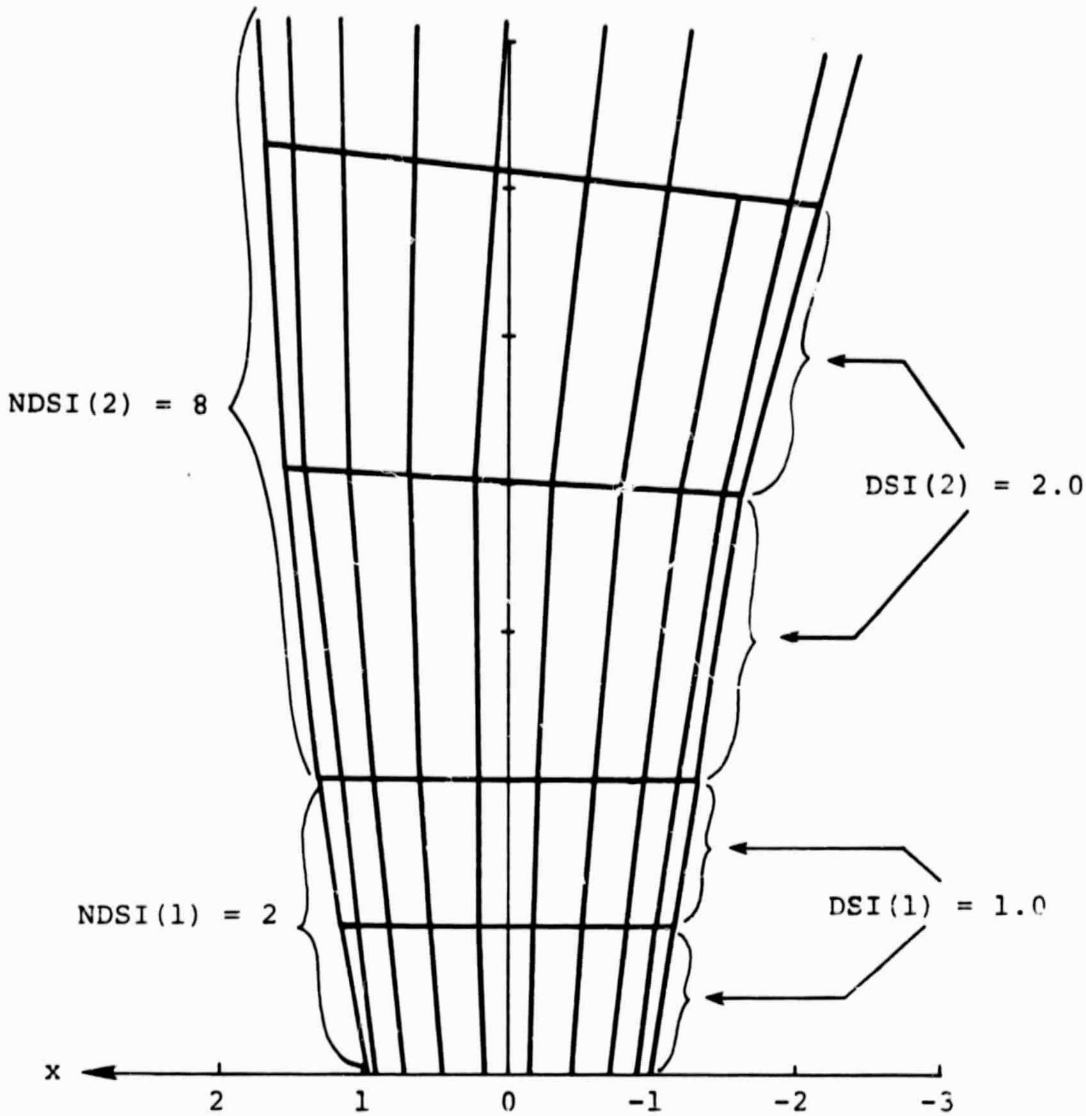
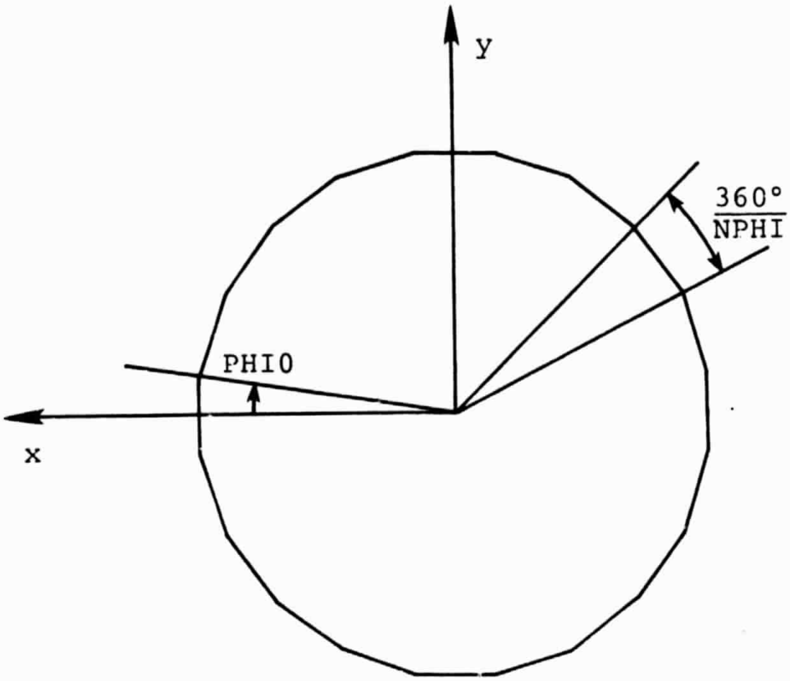


Figure 8.- Typical field-point coordinate geometry.



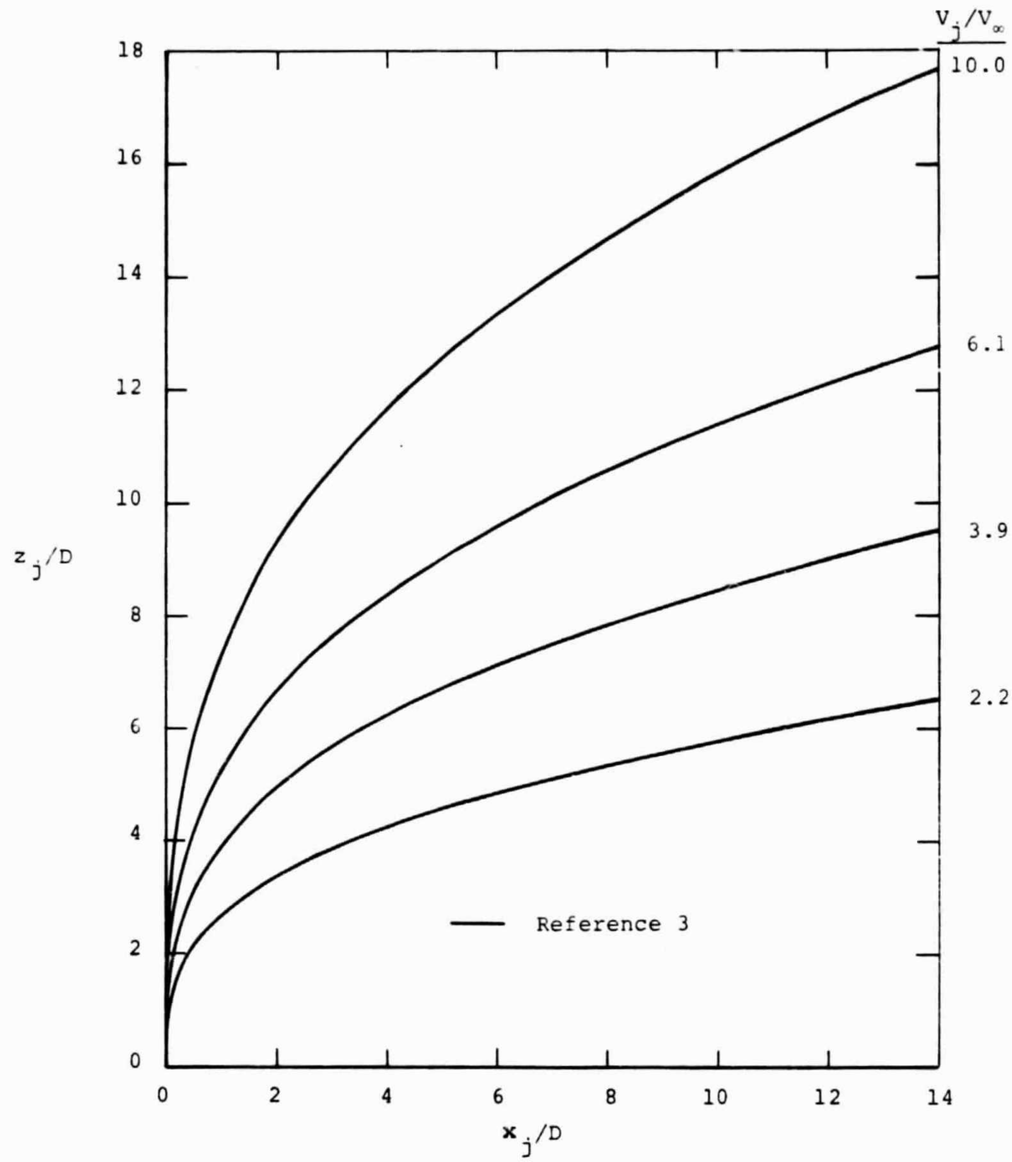
(a) Side view of the
lower part

Figure 9.- Panel layout for a typical blockage model panel layout; NDS = 2, NDSI(1) = 2, NDSI(2) = 8, NPHI = 20, PHI0 = 9°.



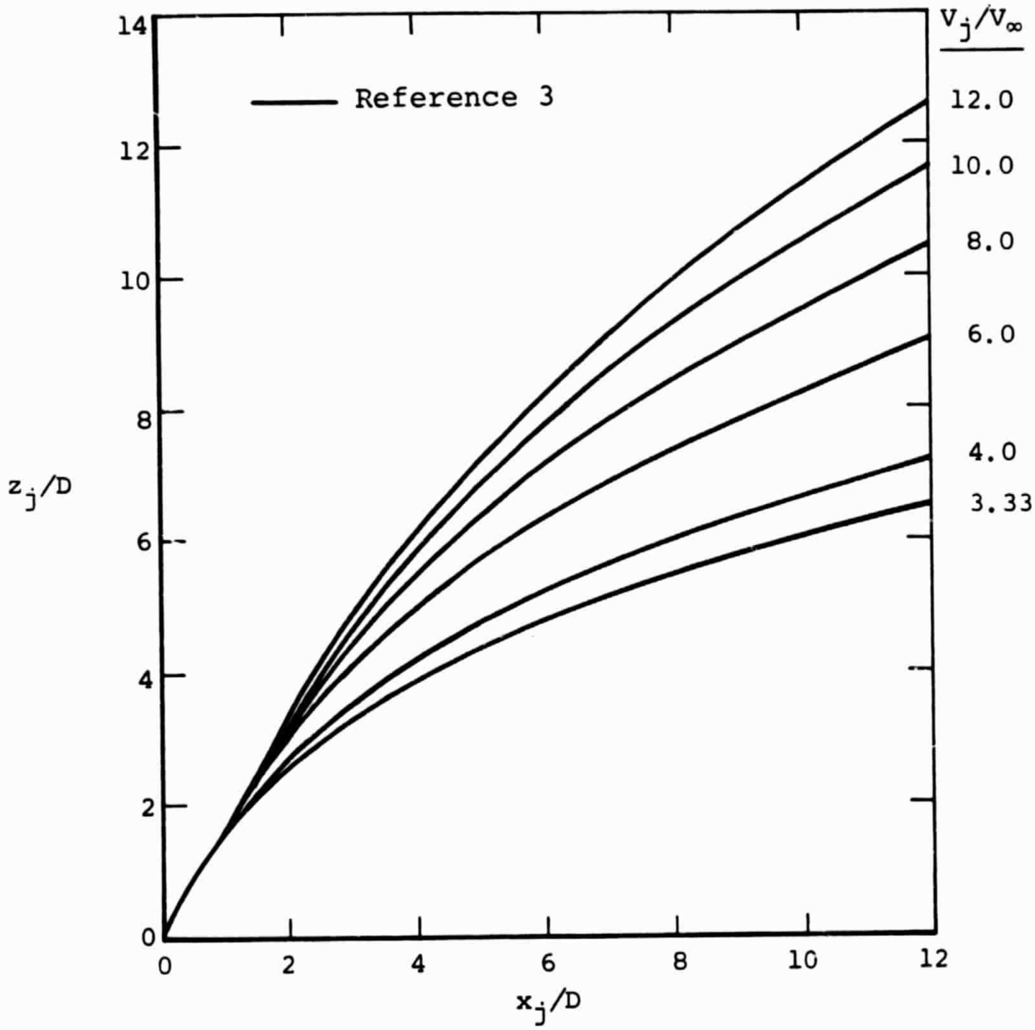
(b) Top view of exit plane

Figure 9.- Concluded.



(a) $\delta_j = 90°$, $\theta = 0°$

Figure 10.- Calculated centerline shapes for a jet exhausting from a flat plate.



(b) $\delta_j = 60^\circ$, $\theta = 30^\circ$

Figure 10.- Concluded.

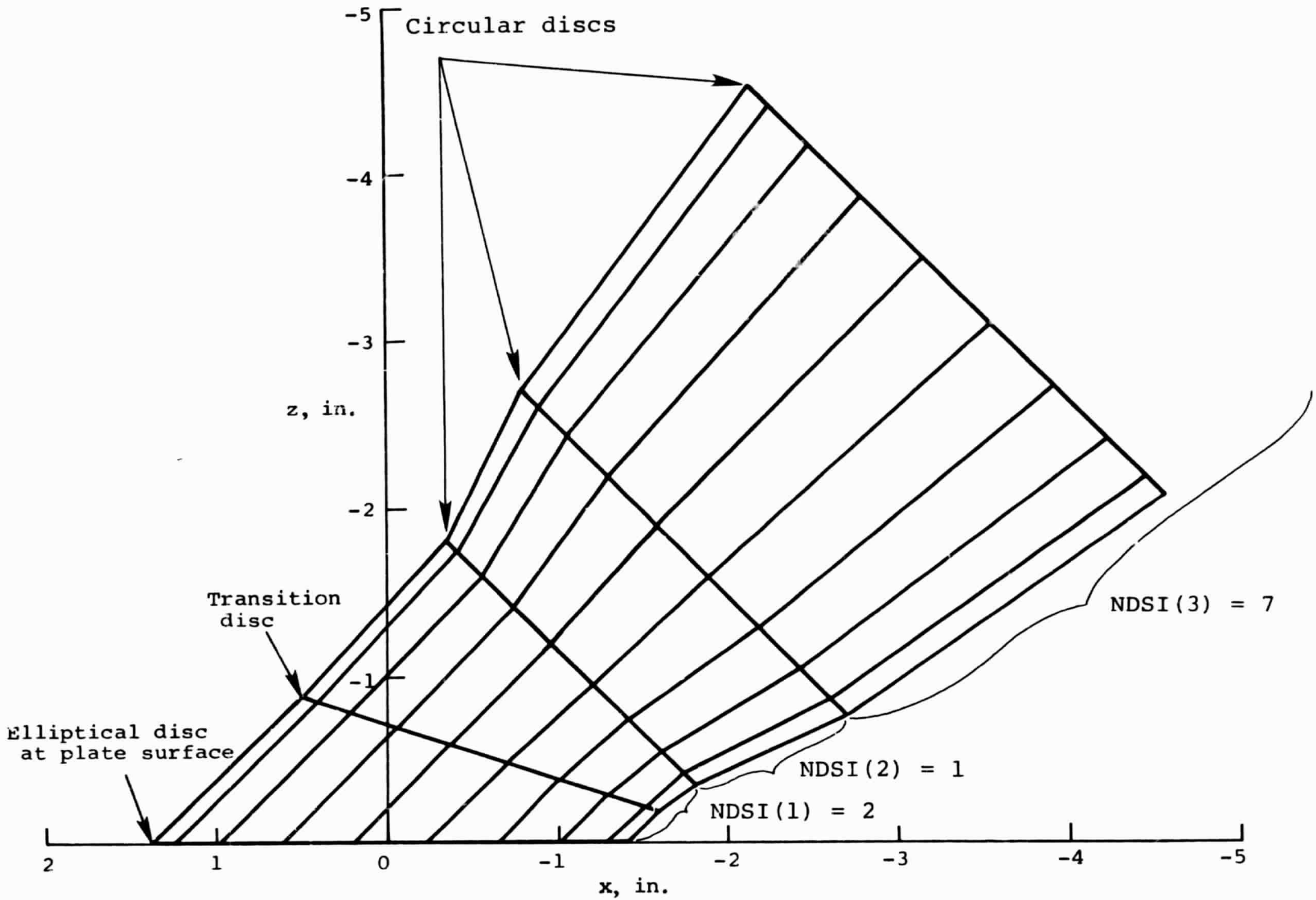
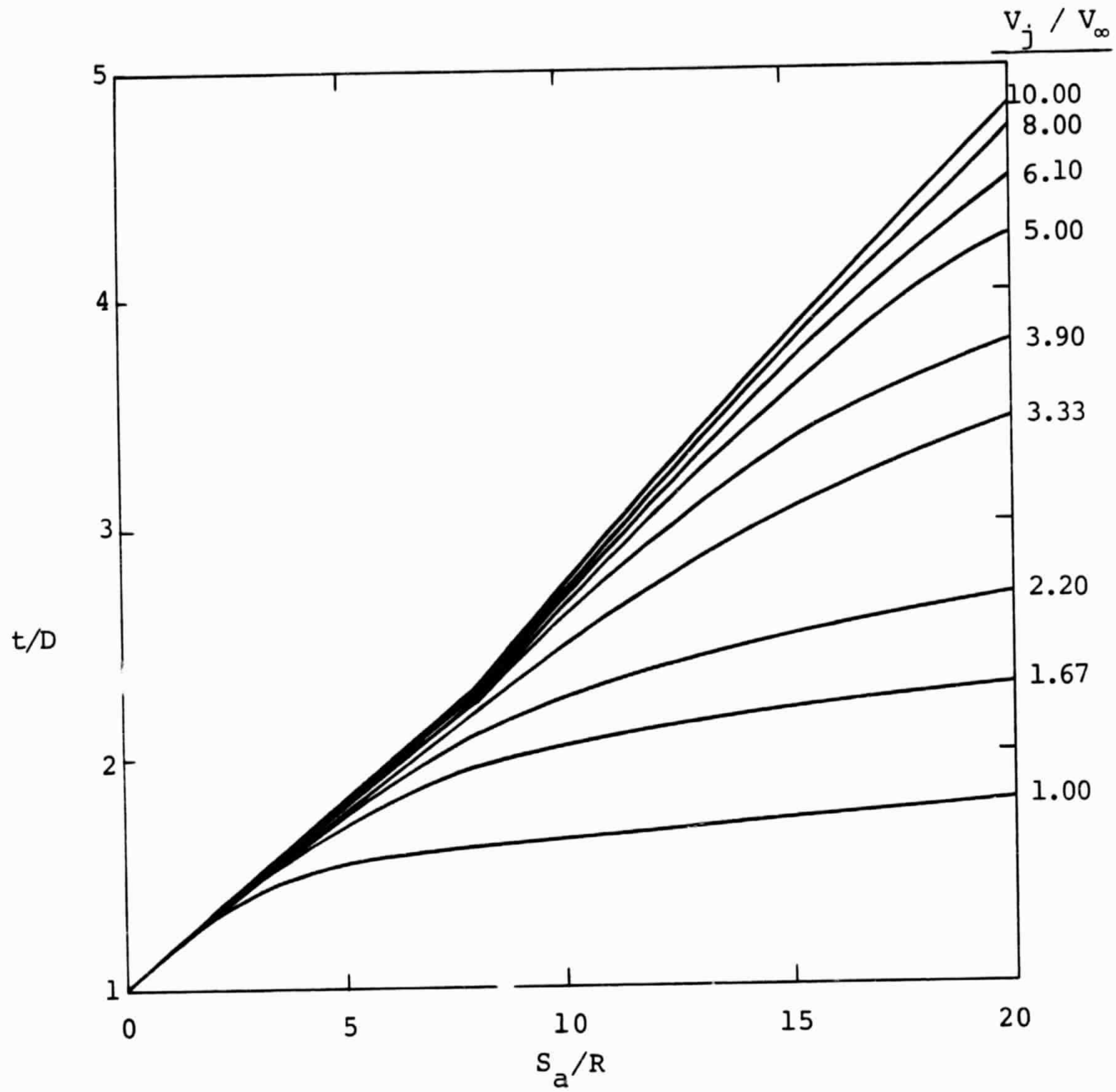
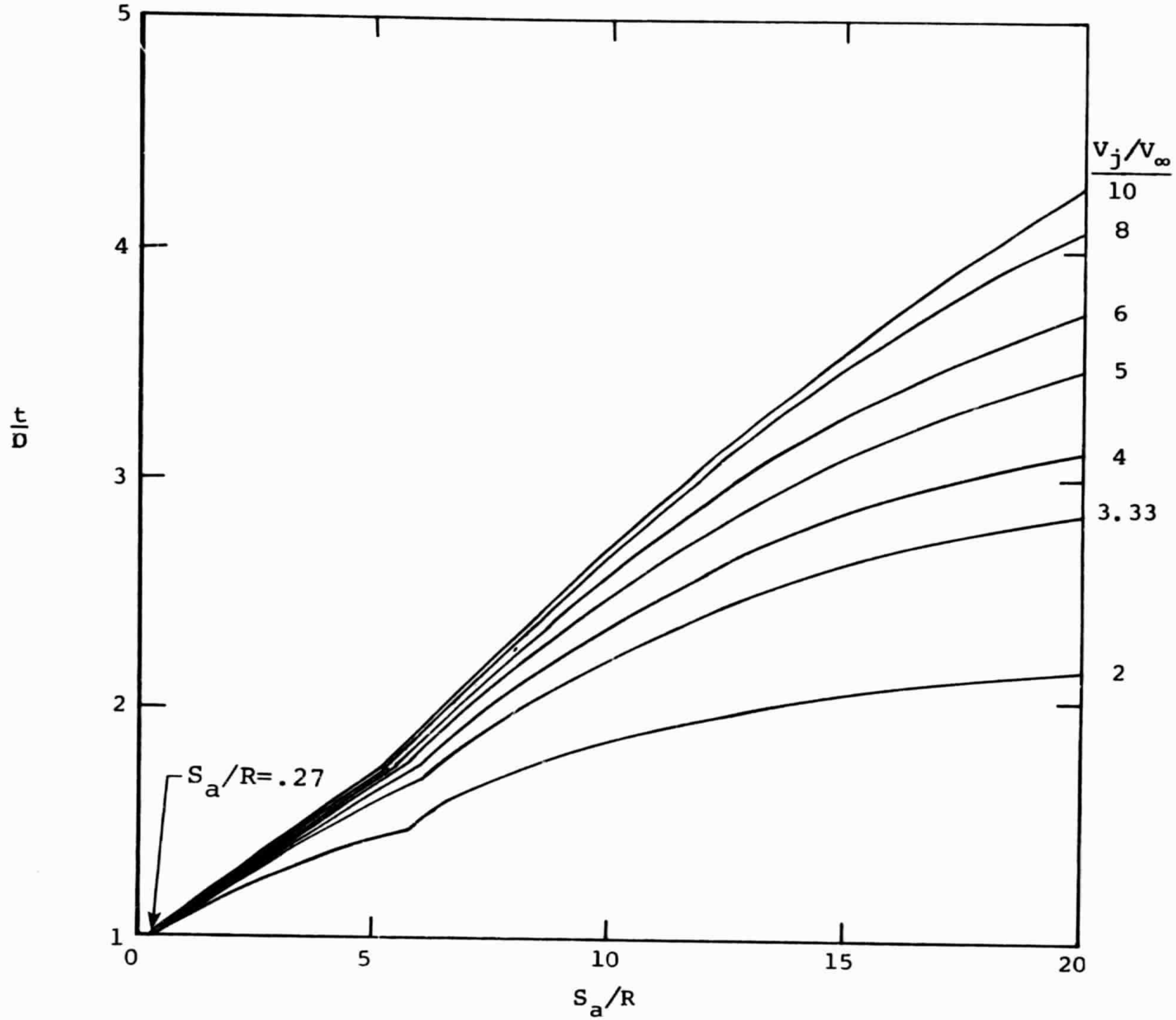


Figure 11.- Side view of the blockage model panel layout for a jet exhausting from a flat plate; $V_j/V_\infty = 12.0$, $\theta = 45^\circ$.



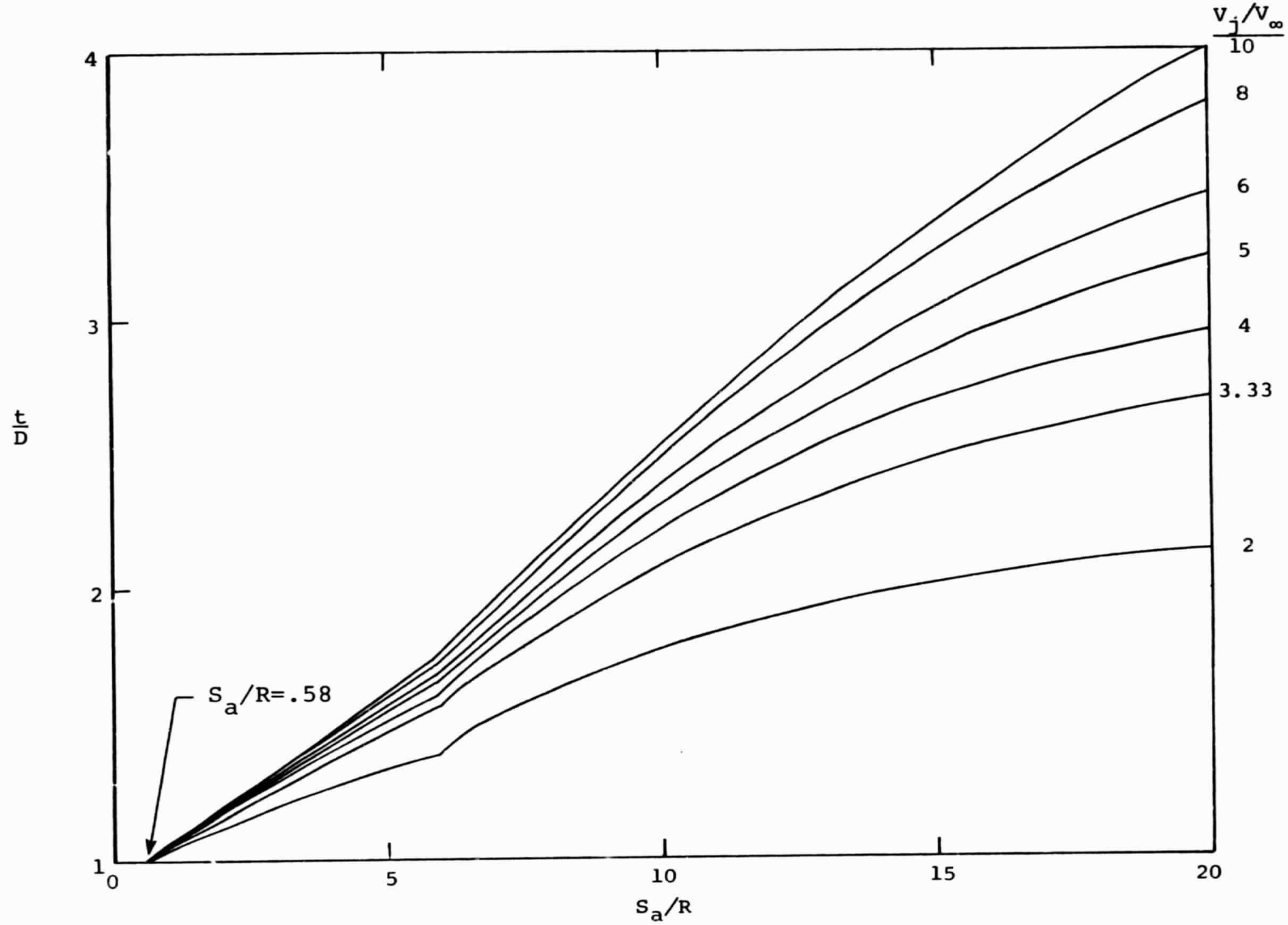
(a) $\delta_j = 90°, \theta = 0°$

Figure 12.- Jet expansion curves.



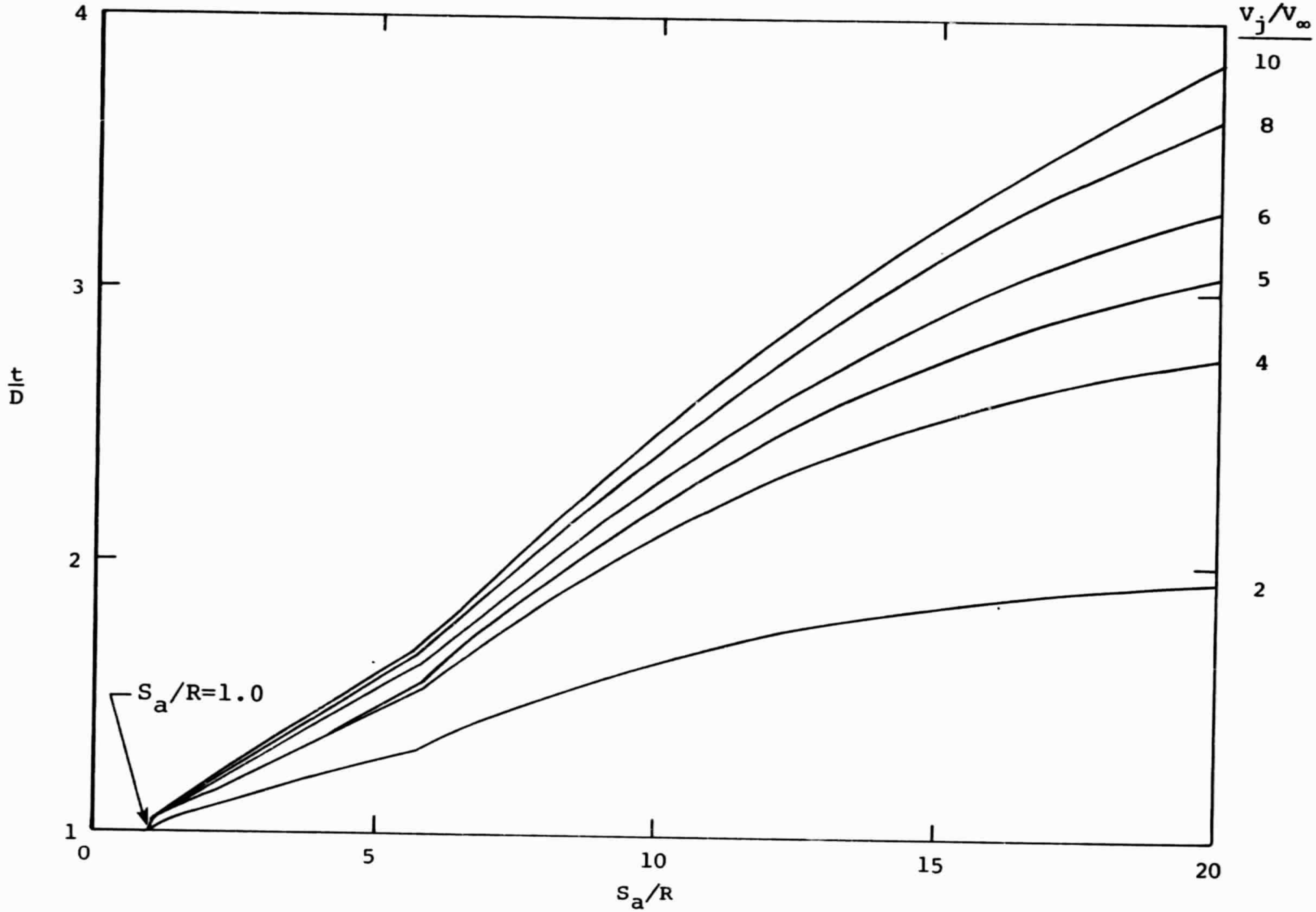
(b) δ_j = 75°, θ = 15°

Figure 12.- Continued.



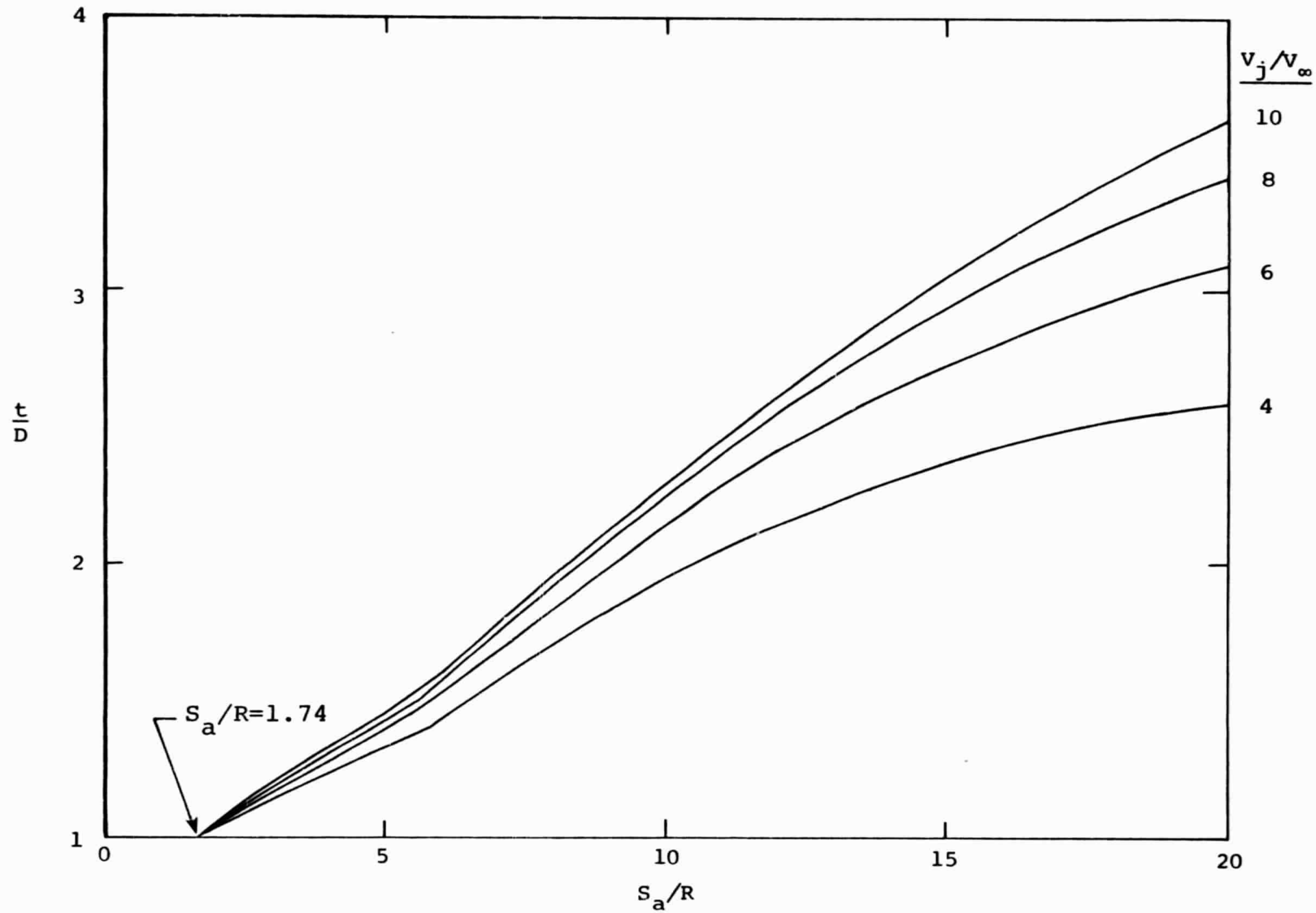
(c) $\delta_j = 60°$, $\theta = 30°$

Figure 12.- Continued.



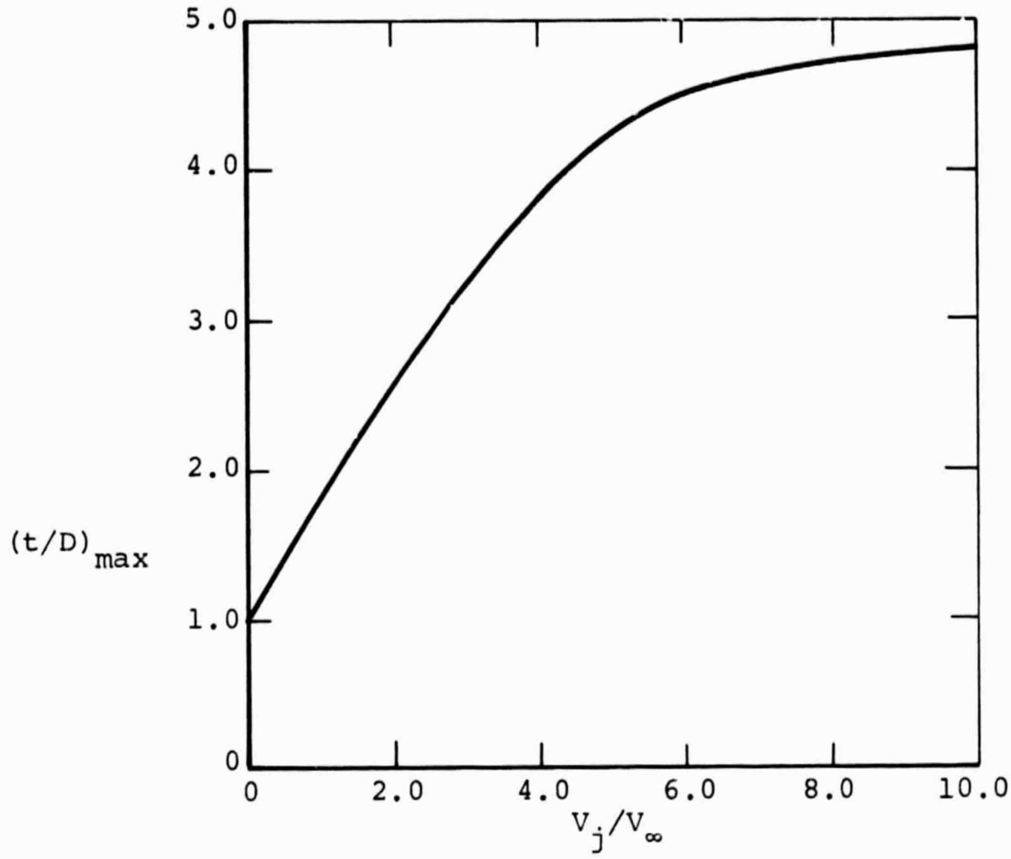
(d) $\delta_j = 45°$, $\theta = 45°$

Figure 12.- Continued.



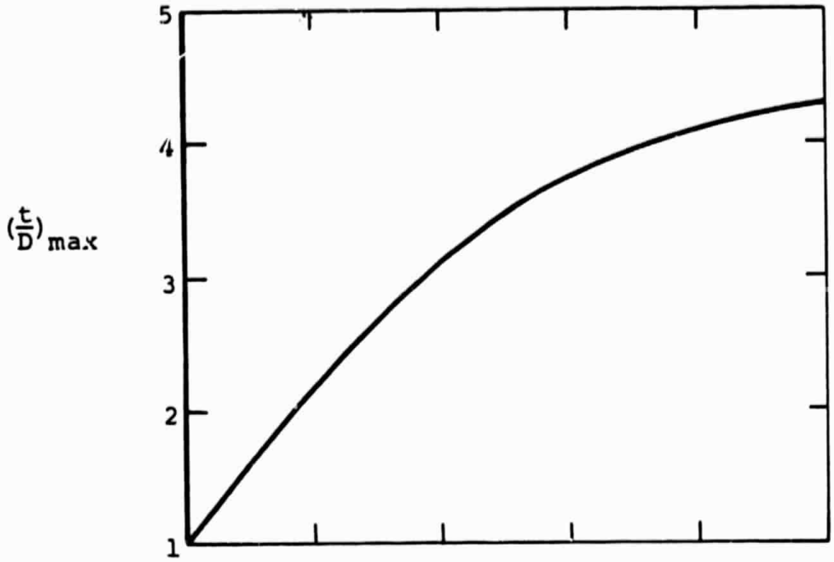
(e) $\delta_j = 30°$, $\theta = 60°$

Figure 12.- Concluded.

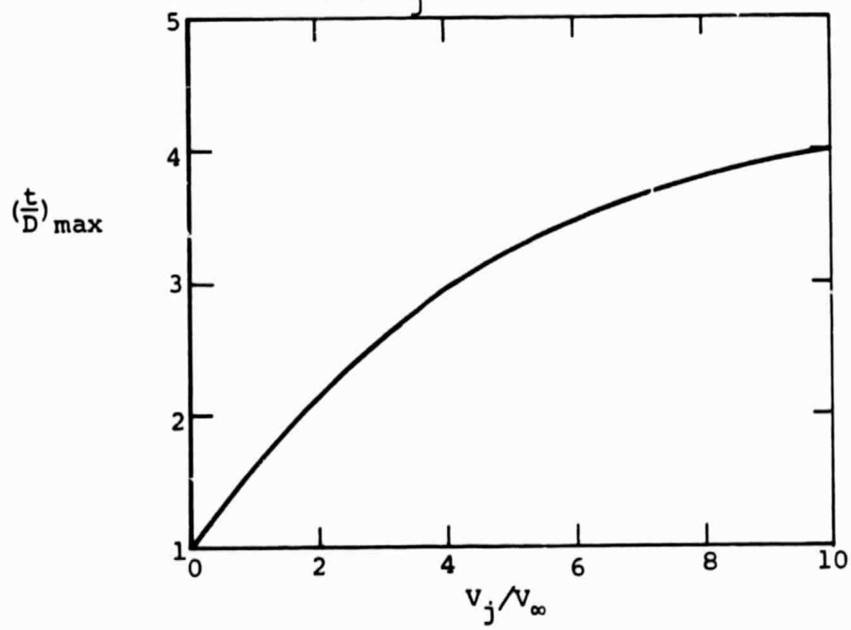


(a) $\delta_j = 90°$, $\theta = 0°$

Figure 13.- Maximum jet radius variation with jet velocity ratio for a jet exhausting from a flat plate, $S_a/R = 20$.

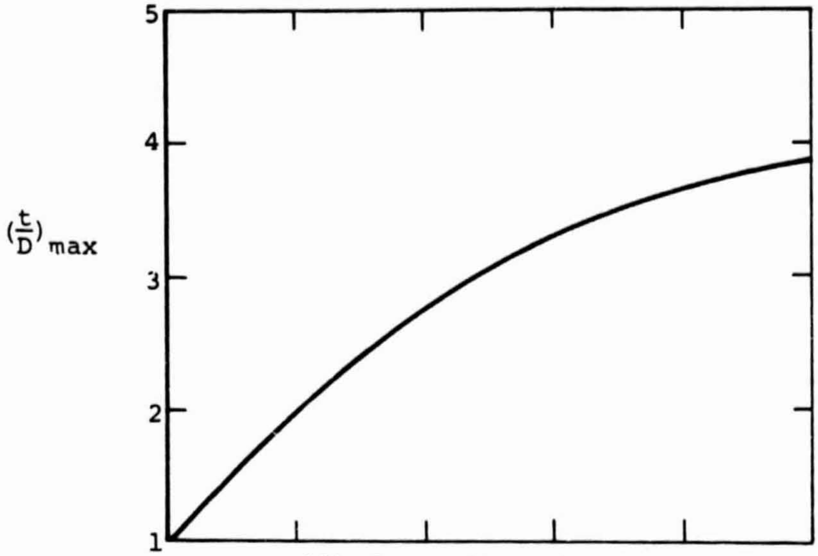


(b) $\delta_j = 75°$, $\theta = 15°$

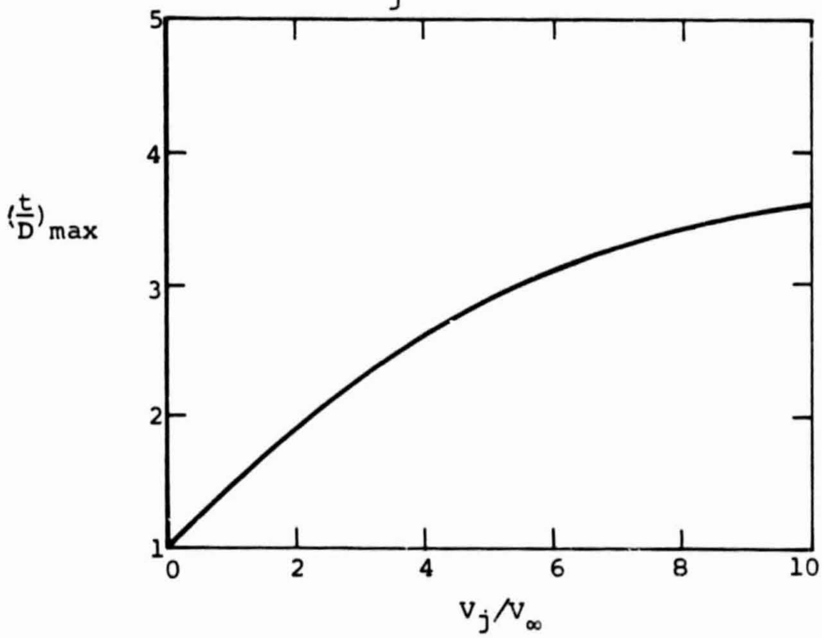


(c) $\delta_j = 60°$, $\theta = 30°$

Figure 13.- Continued.



(d) $\delta_j = 45°$, $\theta = 45°$



(e) $\delta_j = 30°$, $\theta = 60°$

Figure 13.- Concluded.

```
Item

 1        2  22
 2        VJ/VO = 8.0,  THETA = 60 DEG.  (DELTAJ = 30 DEG.)
          CALCULATION TO OBTAIN NEW CORRELATION FACTORS
 3       8.0       0.0      0.0      0.0      60.
 4        0.0      0.0      0.0      1.0
          .346     0.0      .200     1.0
          .8665    0.0      .500     1.0
         1.475     0.0      .850     1.0
         1.736     0.0      1.00     1.05
         2.173     0.0      1.25     1.13
         2.611     0.0      1.50     1.18
         3.495     0.0      2.00     1.31
         4.391     0.0      2.50     1.43
         4.844     0.0      2.75     1.50
         5.302     0.0      3.00     1.61
         6.230     0.0      3.50     1.78
         7.178     0.0      4.00     1.96
         8.150     0.0      4.50     2.14
         9.149     0.0      5.00     2.31
        11.236     0.0      6.00     2.67
        12.331     0.0      6.50     2.81
        13.464     0.0      7.00     2.96
        14.638     0.0      7.50     3.10
        15.856     0.0      8.00     3.23
        17.121     0.0      8.50     3.35
        18.436     0.0      9.00     3.46
 5         0    1    1    1    1    0
 8         7   19
 9         0.0      30.      60.      90.      120.     150.     180.
10         1.5      1.6      1.8      2.0      2.4      2.8      3.2      3.6
           4.0      4.5      5.0      5.5      6.0      6.5      7.0      7.5
           8.0      9.0      10.0
11         20   3    2    1    7
12         9.0      .40      1.0      2.25
```

(a) Sample case 1

Figure 14.- Sample input decks for Program JETPLT.

Item								
1	3 20							
2	VJ/VO = 3.9, THETA = 15 DEG. (DELTAJ = 75 DEG.)							
	CALCULATION TO OBTAIN PRESSURES (INCLUDING CORRELATION							
	FACTORS) AT PLATE FIELD POINTS							
3	3.9	0.0	0.0	0.0	15.			
4	0.000	0.0	0.0	1.0				
	0.054	0.0	.20	1.0				
	0.134	0.0	.50	1.042				
	0.272	0.0	1.0	1.113				
	0.416	0.0	1.5	1.184				
	0.569	0.0	2.0	1.254				
	0.917	0.0	3.0	1.394				
	1.340	0.0	4.0	1.534				
	1.863	0.0	5.0	1.674				
	2.170	0.0	5.5	1.744				
	2.512	0.0	6.0	1.846				
	3.312	0.0	7.0	2.051				
	4.287	0.0	8.0	2.256				
	5.464	0.0	9.0	2.455				
	6.866	0.0	10.	2.642				
	8.520	0.0	11.	2.816				
	9.449	0.0	11.5	2.889				
	10.450	0.0	12.	2.956				
	12.682	0.0	13.	3.079				
	13.918	0.0	13.5	3.129				
5	0 1 1 1 1 0							
8	7 19							
9	0.0	30.	60.	90.	120.	150.	180.	
10	1.5	1.6	1.8	2.0	2.4	2.8	3.2	3.6
	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5
	8.0	9.0	10.0					
11	20 3 2 1 7							
12	9.0	.40	1.0	2.25				

(b) Sample case 2

Figure 14.- Continued.

```
Item

 1        2   20
 2       VJ/VO = 8.0,  THETA = 0 DEG.  (DELTAJ = 90 DEG.)
         FORCE AND MOMENT CALCULATION
 3      8.0         0.0       0.0       0.0       0.
 4       0.0       0.0       0.0       1.0
         .001      0.0       1.0       1.16
         .008      0.0       2.0       1.32
         .026      0.0       3.0       1.47
         .063      0.0       4.0       1.63
         .122      0.0       5.0       1.79
         .211      0.0       6.0       1.95
         .335      0.0       7.0       2.10
         .500      0.0       8.0       2.26
         .712      0.0       9.0       2.48
         .977      0.0      10.0       2.70
        1.300      0.0      11.0       2.91
        1.688      0.0      12.0       3.14
        2.146      0.0      13.0       3.39
        2.680      0.0      14.0       3.61
        3.296      0.0      15.0       3.86
        4.000      0.0      16.0       4.10
        4.798      0.0      17.0       4.32
        5.695      0.0      18.0       4.59
        6.698      0.0      19.0       4.87
 5        0    0    0    0    0    1
 6       30.0       5
 7       3.0      5.0       7.0       9.0       11.0
11        20    2    2    8
12       9.0       1.0       2.0
```

(c) Sample case 3

Figure 14.- Concluded.

VJ/V0 = 8.0, THETA = 60 DEG. (DELTAJ = 30 DEG.)
CALCULATION TO OBTAIN NEW CORRELATION FACTORS

JET PARAMETERS	VJET/VINF	EFFECTIVE VJET/VINF	XQ	YQ	ZQ	NCYL
	8.0000	4.0000	0.0000	0.0000	0.0000	22

XCL	YCL	ZCL	A	P	SCL	THETA
0.00000	0.00000	0.00000	1.00000	6.283	0.000	60.000
0.34600	0.00000	0.20000	1.00000	6.283	0.400	60.006
0.86650	0.00000	0.50000	1.00000	6.283	1.000	60.068
1.47500	0.00000	0.85000	1.00000	6.283	1.702	60.103
1.73600	0.00000	1.00000	1.05000	6.597	2.003	60.170
2.17300	0.00000	1.25000	1.13000	7.100	2.507	60.255
2.61100	0.00000	1.50000	1.18000	7.414	3.011	60.395
3.49500	0.00000	2.00000	1.31000	8.231	4.027	60.672
4.39100	0.00000	2.50000	1.43000	8.985	5.053	60.972
4.84400	0.00000	2.75000	1.50000	9.425	5.570	61.239
5.30200	0.00000	3.00000	1.61000	10.116	6.092	61.528
6.23000	0.00000	3.50000	1.78000	11.184	7.146	61.938
7.17800	0.00000	4.00000	1.96000	12.315	8.218	62.485
8.15000	0.00000	4.50000	2.14000	13.446	9.311	63.095
9.14900	0.00000	5.00000	2.31000	14.514	10.428	63.905
11.23600	0.00000	6.00000	2.67000	16.776	12.742	64.928
12.33100	0.00000	6.50000	2.81000	17.656	13.946	65.823
13.46400	0.00000	7.00000	2.96000	18.598	15.185	66.559
14.63800	0.00000	7.50000	3.10000	19.478	16.461	67.306
15.85600	0.00000	8.00000	3.23000	20.295	17.777	68.057
17.12100	0.00000	8.50000	3.35000	21.049	19.137	68.808
18.43600	0.00000	9.00000	3.46000	21.740	20.544	69.182

OPTIONS...

NP	NVEL	NOUTA	NOUTB	NOUTC	NOUTD	NFORC
133	0	1	1	1	1	0

ENTRAINMENT MODEL INDUCED VELOCITY FIELD IN PLATE COORDINATE SYSTEM

N	XB	YB	ZB	U/V0	V/V0	W/V0	VT/V0
1	1.50000	0.00000	0.00000	-0.10326	0.00000	0.00000	0.10326
2	1.60000	0.00000	0.00000	-0.09716	0.00000	0.00000	0.09716
3	1.80000	0.00000	0.00000	-0.08692	0.00000	0.00000	0.08692
4	2.00000	0.00000	0.00000	-0.07863	0.00000	0.00000	0.07863
5	2.40000	0.00000	0.00000	-0.06602	0.00000	0.00000	0.06602
6	2.80000	0.00000	0.00000	-0.05685	0.00000	0.00000	0.05685
7	3.20000	0.00000	0.00000	-0.04985	0.00000	0.00000	0.04985
8	3.60000	0.00000	0.00000	-0.04433	0.00000	0.00000	0.04433
9	4.00000	0.00000	0.00000	-0.03985	0.00000	0.00000	0.03985
10	4.50000	0.00000	0.00000	-0.03531	0.00000	0.00000	0.03531
11	5.00000	0.00000	0.00000	-0.03163	0.00000	0.00000	0.03163
12	5.50000	0.00000	0.00000	-0.02859	0.00000	0.00000	0.02859
13	6.00000	0.00000	0.00000	-0.02603	0.00000	0.00000	0.02603
14	6.50000	0.00000	0.00000	-0.02384	0.00000	0.00000	0.02384
15	7.00000	0.00000	0.00000	-0.02196	0.00000	0.00000	0.02196
16	7.50000	0.00000	0.00000	-0.02031	0.00000	0.00000	0.02031
17	8.00000	0.00000	0.00000	-0.01887	0.00000	0.00000	0.01887
18	9.00000	0.00000	0.00000	-0.01645	0.00000	0.00000	0.01645
19	10.00000	0.00000	0.00000	-0.01450	0.00000	0.00000	0.01450
20	1.29904	0.75000	0.00000	-0.10277	-0.02807	0.00000	0.10654
21	1.38564	0.80000	0.00000	-0.09673	-0.02647	0.00000	0.10028
22	1.55885	0.90000	0.00000	-0.08654	-0.02380	0.00000	0.08976
23	1.73205	1.00000	0.00000	-0.07832	-0.02165	0.00000	0.08126

(a) Page 1

Figure 15.- Output for Sample case 1.

BLOCKAGE MODEL

(1) JET PARAMETERS	NPHI	NPNLS	NDS	NDSI		
	20	200	3	2	1	7
	PHI(0)			DSI		
	9.00			0.40	1.00	2.25

QUADRILATERAL CORNER POINTS

N	X	Y	Z
1	1.97538	0.15643	0.00000
2	1.78201	0.45399	0.00000
3	1.41421	0.70711	0.00000
4	0.90798	0.89101	0.00000
5	0.31287	0.98769	0.00000
6	-0.31287	0.98769	0.00000
7	-0.90798	0.89101	0.00000
8	-1.41421	0.70711	0.00000
9	-1.78201	0.45399	0.00000
10	-1.97538	0.15643	0.00000
11	-1.97538	-0.15644	0.00000
12	-1.78201	-0.45399	0.00000
13	-1.41421	-0.70711	0.00000
14	-0.90798	-0.89101	0.00000
15	-0.31287	-0.98769	0.00000
16	0.31287	-0.98769	0.00000
17	0.90798	-0.89101	0.00000
18	1.41422	-0.70711	0.00000
19	1.78201	-0.45399	0.00000
20	1.97538	-0.15643	0.00000
21	0.29819	0.15801	-0.96833
22	0.17753	0.45856	-0.92635
23	-0.05197	0.71423	-0.84650
24	-0.36787	0.89998	-0.73661
25	-0.73928	0.99764	-0.60746
26	-1.12988	0.99764	-0.47170
27	-1.50154	0.89998	-0.34269
28	-1.81803	0.71423	-0.23315
29	-2.04859	0.45856	-0.15391
30	-2.17042	0.15801	-0.11261
31	-2.17042	-0.15801	-0.11261
32	-2.04859	-0.45856	-0.15391
33	-1.81803	-0.71423	-0.23315
34	-1.50154	-0.89998	-0.34269
35	-1.12988	-0.99764	-0.47170
36	-0.73928	-0.99764	-0.60746
37	-0.36787	-0.89998	-0.73662
38	-0.05197	-0.71423	-0.84650
39	0.17753	-0.45856	-0.92635
40	0.29819	-0.15801	-0.96833
41	-1.34289	0.16811	-1.99790
42	-1.39453	0.48786	-1.90774
43	-1.49275	0.75986	-1.73626
44	-1.62794	0.95748	-1.50024
45	-1.78687	1.06138	-1.22277
46	-1.95398	1.06138	-0.93103
47	-2.11291	0.95748	-0.65357
48	-2.24810	0.75986	-0.41754
49	-2.34632	0.48786	-0.24606
50	-2.39796	0.16811	-0.15591
51	-2.39796	-0.16811	-0.15591
52	-2.34632	-0.48786	-0.24606
53	-2.24810	-0.75986	-0.41754
54	-2.11291	-0.95748	-0.6535[illegible]

(b) Page 4

Figure 15. Continued.

187	-15.49528	2.79187	-6.31420
188	-15.79880	2.21564	-5.58146
189	-16.01933	1.42253	-5.04910
190	-16.13526	0.49017	-4.76922
191	-16.13526	-0.49017	-4.76922
192	-16.01932	-1.42253	-5.04910
193	-15.79880	-2.21565	-5.58147
194	-15.49528	-2.79188	-6.31420
195	-15.13847	-3.09482	-7.17559
196	-14.76330	-3.09482	-8.08130
197	-14.40649	-2.79187	-8.94269
198	-14.10296	-2.21564	-9.67542
199	-13.88244	-1.42253	-10.20779
200	-13.76651	-0.49017	-10.48766
201	-15.90121	0.52370	-11.57325
202	-16.01829	1.51985	-11.27150
203	-16.24099	2.36722	-10.69754
204	-16.54751	2.98287	-9.90755
205	-16.90785	3.30653	-8.97887
206	-17.28673	3.30653	-8.00239
207	-17.64706	2.98287	-7.07370
208	-17.95358	2.36722	-6.28371
209	-18.17628	1.51985	-5.70975
210	-18.29336	0.52370	-5.40800
211	-18.29336	-0.52371	-5.40800
212	-18.17628	-1.51985	-5.70975
213	-17.95358	-2.36722	-6.28371
214	-17.64706	-2.98287	-7.07370
215	-17.28673	-3.30653	-8.00239
216	-16.90785	-3.30653	-8.97887
217	-16.54751	-2.98287	-9.90756
218	-16.24099	-2.36721	-10.69755
219	-16.01829	-1.51984	-11.27151
220	-15.90121	-0.52370	-11.57325

QUADRILATERAL CONTROL POINTS

N	X	Y	Z	GAMMA/4 PI
1	1.05828	0.30675	-0.47367	-1.49465
2	0.83045	0.58347	-0.44321	-1.47935
3	0.47559	0.80308	-0.39578	-1.45434
4	0.02842	0.94408	-0.33602	-1.42061
5	-0.46729	0.99266	-0.26979	-1.38035
6	-0.96307	0.94408	-0.20360	-1.33632
7	-1.41044	0.80308	-0.14396	-1.28981
8	-1.76571	0.58347	-0.09676	-1.24127
9	-1.99410	0.30675	-0.06663	-1.19638
10	-2.07290	0.00000	-0.05630	-1.17540
11	-1.99410	-0.30675	-0.06663	-1.19638
12	-1.76571	-0.58347	-0.09676	-1.24127
13	-1.41044	-0.80308	-0.14396	-1.28981
14	-0.96307	-0.94408	-0.20360	-1.33632
15	-0.46729	-0.99266	-0.26979	-1.38035
16	0.02843	-0.94408	-0.33602	-1.42061
17	0.47559	-0.80308	-0.39578	-1.45434
18	0.83045	-0.58347	-0.44321	-1.47935
19	1.05828	-0.30675	-0.47367	-1.49465
20	1.13678	0.00000	-0.48416	-1.49980
21	-0.56542	0.31814	-1.45008	-1.41840
22	-0.69043	0.60513	-1.35421	-1.40478
23	-0.88513	0.83289	-1.20490	-1.38325
24	-1.13049	0.97912	-1.01677	-1.35539
25	-1.40250	1.02951	-0.80824	-1.32307
26	-1.67456	0.97912	-0.59975	-1.28811
27	-1.92015	0.83289	-0.41174	-1.25195
28	-2.11526	0.60513	-0.26266	-1.21595

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VELOCITY COMPONENTS INDUCED BY BLOCKAGE MODEL

N	XCP	YCP	ZCP	U/V0	V/V0	W/V0
1	1.50	0.00	0.00	0.3835	0.0000	0.0000
2	1.60	0.00	0.00	0.3647	0.0000	0.0000
3	1.80	0.00	0.00	0.3326	0.0000	0.0000
4	2.00	0.00	0.00	0.2476	0.0000	0.0000
5	2.40	0.00	0.00	0.1254	0.0000	0.0000
6	2.80	0.00	0.00	0.0891	0.0000	0.0000
7	3.20	0.00	0.00	0.0693	0.0000	0.0000
8	3.60	0.00	0.00	0.0567	0.0000	0.0000
9	4.00	0.00	0.00	0.0478	0.0000	0.0000
10	4.50	0.00	0.00	0.0398	0.0000	0.0000
11	5.00	0.00	0.00	0.0339	0.0000	0.0000
12	5.50	0.00	0.00	0.0294	0.0000	0.0000
13	6.00	0.00	0.00	0.0259	0.0000	0.0000
14	6.50	0.00	0.00	0.0230	0.0000	0.0000
15	7.00	0.00	0.00	0.0207	0.0000	0.0000
16	7.50	0.00	0.00	0.0187	0.0000	0.0000
17	8.00	0.00	0.00	0.0170	0.0000	0.0000
18	9.00	0.00	0.00	0.0142	0.0000	0.0000
19	10.00	0.00	0.00	0.0121	0.0000	0.0000
20	1.30	0.75	0.00	-0.2152	-1.0056	0.0000
21	1.39	0.80	0.00	-0.1947	-0.0745	0.0000
22	1.56	0.90	0.00	0.0554	0.0900	0.0000
23	1.73	1.00	0.00	0.0758	0.0806	0.0000
24	2.08	1.20	0.00	0.0734	0.0588	0.0000
25	2.42	1.40	0.00	0.0629	0.0433	0.0000
26	2.77	1.60	0.00	0.0533	0.0335	0.0000
27	3.12	1.80	0.00	0.0457	0.0270	0.0000
28	3.46	2.00	0.00	0.0397	0.0225	0.0000
29	3.90	2.25	0.00	0.0339	0.0186	0.0000
30	4.33	2.50	0.00	0.0293	0.0157	0.0000
31	4.76	2.75	0.00	0.0258	0.0136	0.0000
32	5.20	3.00	0.00	0.0229	0.0120	0.0000
33	5.63	3.25	0.00	0.0204	0.0107	0.0000
34	6.06	3.50	0.00	0.0184	0.0096	0.0000
35	6.50	3.75	0.00	0.0167	0.0087	0.0000
36	6.93	4.00	0.00	0.0152	0.0080	0.0000
37	7.79	4.50	0.00	0.0128	0.0068	0.0000
38	8.66	5.00	0.00	0.0109	0.0059	0.0000
39	0.75	1.30	0.00	-0.0158	0.0298	0.0000
40	0.80	1.39	0.00	-0.0006	0.0564	0.0000
41	0.90	1.56	0.00	0.0166	0.0746	0.0000
42	1.00	1.73	0.00	0.0243	0.0758	0.0000
43	1.20	2.08	0.00	0.0288	0.0665	0.0000
44	1.40	2.42	0.00	0.0284	0.0559	0.0000
45	1.60	2.77	0.00	0.0266	0.0473	0.0000
46	1.80	3.12	0.00	0.0245	0.0406	0.0000
47	2.00	3.46	0.00	0.0225	0.0354	0.0000
48	2.25	3.90	0.00	0.0202	0.0304	0.0000
49	2.50	4.33	0.00	0.0181	0.0266	0.0000
50	2.75	4.76	0.00	0.0163	0.0236	0.0000
51	3.00	5.20	0.00	0.0147	0.0212	0.0000
52	3.25	5.63	0.00	0.0134	0.0192	0.0000
53	3.50	6.06	0.00	0.0121	0.0175	0.0000
54	3.75	6.50	0.00	0.0111	0.0161	0.0000
55	4.00	6.93	0.00	0.0101	0.0148	0.0000
56	4.50	7.79	0.00	0.0085	0.0128	0.0000
57	5.00	8.66	0.00	0.0071	0.0111	0.0000
58	0.00	1.50	0.00	-0.0585	0.0058	0.0000
59	0.00	1.60	0.00	-0.0506	0.0302	0.0000
60	0.00	1.90	0.00	-0.0386	0.0516	0.0000
61	0.00	2.00	0.00	-0.0300	0.0575	0.0000

(d) Page 11

Figure 15.- Continued.

62	0.00	2.40	0.00	-0.0182	0.0556	0.0000
63	0.00	2.80	0.00	-0.0109	0.0501	0.0000
64	0.00	3.20	0.00	-0.0063	0.0447	0.0000
65	0.00	3.60	0.00	-0.0033	0.0403	0.0000
66	0.00	4.00	0.00	-0.0013	0.0366	0.0000
67	0.00	4.50	0.00	0.0002	0.0329	0.0000
68	0.00	5.00	0.00	0.0011	0.0299	0.0000
69	0.00	5.50	0.00	0.0015	0.0275	0.0000
70	0.00	6.00	0.00	0.0016	0.0254	0.0000
71	0.00	6.50	0.00	0.0016	0.0236	0.0000
72	0.00	7.00	0.00	0.0014	0.0220	0.0000
73	0.00	7.50	0.00	0.0012	0.0206	0.0000
74	0.00	8.00	0.00	0.0010	0.0193	0.0000
75	0.00	9.00	0.00	0.0004	0.0170	0.0000
76	0.00	10.00	0.00	-0.0001	0.0150	0.0000
77	-0.75	1.30	0.00	-0.1420	-0.1871	0.0000
78	-0.80	1.39	0.00	-0.1452	-0.1209	0.0000
79	-0.90	1.56	0.00	-0.1372	-0.0639	0.0000
80	-1.00	1.73	0.00	-0.1225	-0.0418	0.0000
81	-1.20	2.08	0.00	-0.0948	-0.0214	0.0000
82	-1.40	2.42	0.00	-0.0743	-0.0111	0.0000
83	-1.60	2.77	0.00	-0.0589	-0.0049	0.0000
84	-1.80	3.12	0.00	-0.0474	-0.0004	0.0000
85	-2.00	3.46	0.00	-0.0387	0.0032	0.0000
86	-2.25	3.90	0.00	-0.0311	0.0069	0.0000
87	-2.50	4.33	0.00	-0.0259	0.0098	0.0000
88	-2.75	4.76	0.00	-0.0225	0.0119	0.0000
89	-3.00	5.20	0.00	-0.0202	0.0133	0.0000
90	-3.25	5.63	0.00	-0.0186	0.0142	0.0000
91	-3.50	6.06	0.00	-0.0175	0.0147	0.0000
92	-3.75	6.50	0.00	-0.0168	0.0148	0.0000
93	-4.00	6.93	0.00	-0.0162	0.0147	0.0000
94	-4.50	7.79	0.00	-0.0154	0.0139	0.0000
95	-5.00	8.66	0.00	-0.0148	0.0127	0.0000
96	-1.30	0.75	0.00	0.5103	-0.3037	0.0000
97	-1.39	0.80	0.00	0.0206	-0.3736	0.0000
98	-1.56	0.90	0.00	-0.2686	-0.5631	0.0000
99	-1.73	1.00	0.00	-0.2639	-0.4934	0.0000
100	-2.08	1.20	0.00	-0.1946	-0.3978	0.0000
101	-2.42	1.40	0.00	-0.1396	-0.3191	0.0000
102	-2.77	1.60	0.00	-0.1067	-0.2527	0.0000
103	-3.12	1.80	0.00	-0.0834	-0.2092	0.0000
104	-3.46	2.00	0.00	-0.0618	-0.1744	0.0000
105	-3.90	2.25	0.00	-0.0474	-0.1346	0.0000
106	-4.33	2.50	0.00	-0.0447	-0.1035	0.0000
107	-4.76	2.75	0.00	-0.0456	-0.0823	0.0000
108	-5.20	3.00	0.00	-0.0461	-0.0681	0.0000
109	-5.63	3.25	0.00	-0.0460	-0.0578	0.0000
110	-6.06	3.50	0.00	-0.0459	-0.0498	0.0000
111	-6.50	3.75	0.00	-0.0458	-0.0436	0.0000
112	-6.93	4.00	0.00	-0.0457	-0.0388	0.0000
113	-7.79	4.50	0.00	-0.0448	-0.0324	0.0000
114	-8.66	5.00	0.00	-0.0434	-0.0284	0.0000
115	-1.50	0.00	0.00	0.8500	0.0000	0.0000
116	-1.60	0.00	0.00	0.8639	0.0000	0.0000
117	-1.80	0.00	0.00	0.8985	0.0000	0.0000
118	-2.00	0.00	0.00	0.9787	0.0000	0.0000
119	-2.40	0.00	0.00	0.1865	0.0000	0.0000
120	-2.80	0.00	0.00	0.3832	0.0000	0.0000
121	-3.20	0.00	0.00	0.1208	0.0000	0.0000
122	-3.60	0.00	0.00	0.1029	0.0000	0.0000
123	-4.00	0.00	0.00	0.1716	0.0000	0.0000
124	-4.50	0.00	0.00	0.1386	0.0000	0.0000
125	-5.00	0.00	0.00	0.0635	0.0000	0.0000
126	-5.50	0.00	0.00	0.0119	0.0000	0.0000
127	-6.00	0.00	0.00	0.0043	0.0000	0.0000

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Figure 15.- Continued.

128	-6.50	0.00	0.00	0.0055	0.0000	0.0000
129	-7.00	0.00	0.00	-0.0048	0.0000	0.0000
130	-7.50	0.00	0.00	-0.0185	0.0000	0.0000
131	-8.00	0.00	0.00	-0.0255	0.0000	0.0000
132	-9.00	0.00	0.00	-0.0272	0.0000	0.0000
133	-10.00	0.00	0.00	-0.0306	0.0000	0.0000

TOTAL JET INDUCED VELOCITY FIELD IN PLATE COORDINATE SYSTEM

N	XB	YB	ZB	U/VO	V/VO	W/VO	VT/VO	CP	R/D
1	1.50000	0.00000	0.00000	-0.71980	0.00000	0.00000	0.71980	0.48188	0.75000
2	1.60000	0.00000	0.00000	-0.73246	0.00000	0.00000	0.73246	0.46350	0.80000
3	1.80000	0.00000	0.00000	-0.75430	0.00000	0.00000	0.75430	0.43104	0.90000
4	2.00000	0.00000	0.00000	-0.83105	0.00000	0.00000	0.83105	0.30935	1.00000
5	2.40000	0.00000	0.00000	-0.94058	0.00000	0.00000	0.94058	0.11532	1.20000
6	2.80000	0.00000	0.00000	-0.96775	0.00000	0.00000	0.96775	0.06346	1.40000
7	3.20000	0.00000	0.00000	-0.98051	0.00000	0.00000	0.98051	0.03860	1.60000
8	3.60000	0.00000	0.00000	-0.98768	0.00000	0.00000	0.98768	0.02449	1.80000
9	4.00000	0.00000	0.00000	-0.99210	0.00000	0.00000	0.99210	0.01574	2.00000
10	4.50000	0.00000	0.00000	-0.99556	0.00000	0.00000	0.99556	0.00886	2.25000
11	5.00000	0.00000	0.00000	-0.99773	0.00000	0.00000	0.99773	0.00453	2.50000
12	5.50000	0.00000	0.00000	-0.99916	0.00000	0.00000	0.99916	0.00168	2.75000
13	6.00000	0.00000	0.00000	-1.00013	0.00000	0.00000	1.00013	-0.00027	3.00000
14	6.50000	0.00000	0.00000	-1.00081	0.00000	0.00000	1.00081	-0.00162	3.25000
15	7.00000	0.00000	0.00000	-1.00129	0.00000	0.00000	1.00129	-0.00259	3.50000
16	7.50000	0.00000	0.00000	-1.00164	0.00000	0.00000	1.00164	-0.00329	3.75000
17	8.00000	0.00000	0.00000	-1.00190	0.00000	0.00000	1.00190	-0.00380	4.00000
18	9.00000	0.00000	0.00000	-1.00222	0.00000	0.00000	1.00222	-0.00444	4.50000
19	10.00000	0.00000	0.00000	-1.00238	0.00000	0.00000	1.00238	-0.00477	5.00000
20	1.29904	0.75000	0.00000	-1.31794	-1.03366	0.00000	1.67494	-1.80542	0.75000
21	1.38564	0.80000	0.00000	-1.29143	-0.10092	0.00000	1.29536	-0.67797	0.80000
22	1.55885	0.90000	0.00000	-1.03111	0.06619	0.00000	1.03323	-0.06757	0.90000
23	1.73205	1.00000	0.00000	-1.00252	0.05895	0.00000	1.00425	-0.00851	1.00000
24	2.07846	1.20000	0.00000	-0.99237	0.04039	0.00000	0.99319	0.01358	1.20000
25	2.42487	1.40000	0.00000	-0.99380	0.02729	0.00000	0.99418	0.01161	1.40000
26	2.77128	1.60000	0.00000	-0.99638	0.01925	0.00000	0.99657	0.00686	1.60000
27	3.11769	1.80000	0.00000	-0.99850	0.01418	0.00000	0.99860	0.00280	1.80000
28	3.46410	2.00000	0.00000	-1.00004	0.01082	0.00000	1.00009	-0.00019	2.00000
29	3.89711	2.25000	0.00000	-1.00134	0.00801	0.00000	1.00137	-0.00274	2.25000
30	4.33013	2.50000	0.00000	-1.00217	0.00613	0.00000	1.00219	-0.00438	2.50000
31	4.76314	2.75000	0.00000	-1.00269	0.00482	0.00000	1.00270	-0.00542	2.75000
32	5.19615	3.00000	0.00000	-1.00304	0.00386	0.00000	1.00305	-0.00611	3.00000
33	5.62917	3.25000	0.00000	-1.00326	0.00313	0.00000	1.00326	-0.00654	3.25000
34	6.06218	3.50000	0.00000	-1.00340	0.00257	0.00000	1.00341	-0.00682	3.50000
35	6.49519	3.75000	0.00000	-1.00348	0.00213	0.00000	1.00348	-0.00697	3.75000
36	6.92820	4.00000	0.00000	-1.00349	0.00178	0.00000	1.00349	-0.00699	4.00000
37	7.79423	4.50000	0.00000	-1.00351	0.00125	0.00000	1.00351	-0.00704	4.50000
38	8.66025	5.00000	0.00000	-1.00345	0.00088	0.00000	1.00345	-0.00692	5.00000
39	0.75000	1.29904	0.00000	-1.11673	-0.02972	0.00000	1.11712	-0.24796	0.75000
40	0.80000	1.38564	0.00000	-1.09561	0.00027	0.00000	1.09561	-0.20035	0.80000
41	0.90000	1.55885	0.00000	-1.06853	0.02407	0.00000	1.06880	-0.14234	0.90000
42	1.00000	1.73205	0.00000	-1.05282	0.02982	0.00000	1.05325	-0.10933	1.00000
43	1.20000	2.07846	0.00000	-1.03604	0.02731	0.00000	1.03640	-0.07413	1.20000
44	1.40000	2.42487	0.00000	-1.02752	0.02166	0.00000	1.02775	-0.05628	1.40000
45	1.60000	2.77128	0.00000	-1.02247	0.01679	0.00000	1.02261	-0.04572	1.60000
46	1.80000	3.11769	0.00000	-1.01913	0.01308	0.00000	1.01921	-0.03879	1.80000
47	2.00000	3.46410	0.00000	-1.01674	0.01030	0.00000	1.01679	-0.03387	2.00000
48	2.25000	3.89711	0.00000	-1.01456	0.00787	0.00000	1.01460	-0.02940	2.25000
49	2.50000	4.33013	0.00000	-1.01295	0.00597	0.00000	1.01296	-0.02610	2.50000
50	2.75000	4.76314	0.00000	-1.01169	0.00464	0.00000	1.01170	-0.02354	2.75000
51	3.00000	5.19615	0.00000	-1.01069	0.00365	0.00000	1.01070	-0.02151	3.00000
52	3.25000	5.62917	0.00000	-1.00987	0.00288	0.00000	1.00987	-0.01984	3.25000
53	3.50000	6.06218	0.00000	-1.00918	0.00228	0.00000	1.00919	-0.01846	3.50000
54	3.75000	6.49519	0.00000	-1.00860	0.00180	0.00000	1.00861	-0.01728	3.75000
55	4.00000	6.92820	0.00000	-1.00810	0.00140	0.00000	1.00810	-0.01627	4.00000

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Figure 15.- Continued.

56	4.50000	7.79423	0.00000	-1.00728	0.00079	0.00000	1.00728	-0.01461	4.50000
57	5.00000	8.66025	0.00000	-1.00663	0.00034	0.00000	1.00663	-0.01330	5.00000
58	0.00000	1.50000	0.00000	-1.15426	-0.09319	0.00000	1.15802	-0.34100	0.75000
59	0.00000	1.60000	0.00000	-1.14070	-0.06321	0.00000	1.14245	-0.30518	0.80000
60	0.00000	1.80000	0.00000	-1.11959	-0.03256	0.00000	1.12006	-0.25454	0.90000
61	0.00000	2.00000	0.00000	-1.10344	-0.01928	0.00000	1.10361	-0.21796	1.00000
62	0.00000	2.40000	0.00000	-1.08023	-0.00988	0.00000	1.08028	-0.16700	1.20000
63	0.00000	2.80000	0.00000	-1.06456	-0.00731	0.00000	1.06458	-0.13333	1.40000
64	0.00000	3.20000	0.00000	-1.05343	-0.00647	0.00000	1.05345	-0.10975	1.60000
65	0.00000	3.60000	0.00000	-1.04522	-0.00609	0.00000	1.04523	-0.09251	1.80000
66	0.00000	4.00000	0.00000	-1.03897	-0.00583	0.00000	1.03899	-0.07949	2.00000
67	0.00000	4.50000	0.00000	-1.03306	-0.00551	0.00000	1.03308	-0.06725	2.25000
68	0.00000	5.00000	0.00000	-1.02862	-0.00518	0.00000	1.02863	-0.05809	2.50000
69	0.00000	5.50000	0.00000	-1.02520	-0.00487	0.00000	1.02521	-0.05105	2.75000
70	0.00000	6.00000	0.00000	-1.02251	-0.00459	0.00000	1.02252	-0.04554	3.00000
71	0.00000	6.50000	0.00000	-1.02035	-0.00435	0.00000	1.02036	-0.04113	3.25000
72	0.00000	7.00000	0.00000	-1.01858	-0.00415	0.00000	1.01859	-0.03753	3.50000
73	0.00000	7.50000	0.00000	-1.01712	-0.00400	0.00000	1.01713	-0.03454	3.75000
74	0.00000	8.00000	0.00000	-1.01588	-0.00388	0.00000	1.01589	-0.03203	4.00000
75	0.00000	9.00000	0.00000	-1.01402	-0.00373	0.00000	1.01403	-0.02826	4.50000
76	0.00000	10.00000	0.00000	-1.01236	-0.00367	0.00000	1.01237	-0.02490	5.00000
77	-0.75000	1.29904	0.00000	-1.22125	-0.33905	0.00000	1.26744	-0.60641	0.75000
78	-0.80000	1.38564	0.00000	-1.22016	-0.26446	0.00000	1.24849	-0.55872	0.80000
79	-0.90000	1.55885	0.00000	-1.20497	-0.19343	0.00000	1.22040	-0.48937	0.90000
80	-1.00000	1.73205	0.00000	-1.18426	-0.16004	0.00000	1.19503	-0.42809	1.00000
81	-1.20000	2.07846	0.00000	-1.14733	-0.12273	0.00000	1.15387	-0.33143	1.20000
82	-1.40000	2.42487	0.00000	-1.11994	-0.10020	0.00000	1.12441	-0.26431	1.40000
83	-1.60000	2.77128	0.00000	-1.09922	-0.08473	0.00000	1.10248	-0.21546	1.60000
84	-1.80000	3.11769	0.00000	-1.08327	-0.07300	0.00000	1.08573	-0.17880	1.80000
85	-2.00000	3.46410	0.00000	-1.07096	-0.06351	0.00000	1.07284	-0.15098	2.00000
86	-2.25000	3.89711	0.00000	-1.05944	-0.05381	0.00000	1.06080	-0.12531	2.25000
87	-2.50000	4.33013	0.00000	-1.05108	-0.04602	0.00000	1.05208	-0.10686	2.50000
88	-2.75000	4.76314	0.00000	-1.04490	-0.03979	0.00000	1.04566	-0.09341	2.75000
89	-3.00000	5.19615	0.00000	-1.04023	-0.03484	0.00000	1.04081	-0.08329	3.00000
90	-3.25000	5.62917	0.00000	-1.03658	-0.03090	0.00000	1.03704	-0.07546	3.25000
91	-3.50000	6.06218	0.00000	-1.03365	-0.02776	0.00000	1.03403	-0.06921	3.50000
92	-3.75000	6.49519	0.00000	-1.03124	-0.02524	0.00000	1.03155	-0.06409	3.75000
93	-4.00000	6.92820	0.00000	-1.02919	-0.02321	0.00000	1.02945	-0.05977	4.00000
94	-4.50000	7.79423	0.00000	-1.02586	-0.020[illegible]	0.00000	1.02506	-0.05279	4.50000
95	-5.00000	8.66025	0.00000	-1.02317	-0.01[illegible]20	0.00000	1.02334	-0.04721	5.00000
96	-1.29904	0.75000	0.00000	-0.51325	-0.51358	0.00000	0.71904	0.48298	0.75000
97	-1.38564	0.80000	0.00000	-1.00220	-0.5[illegible]253	0.00000	1.14929	-0.32086	0.80000
98	-1.55885	0.90000	0.00000	-1.29000	-0.7[illegible]384	0.00000	1.48412	-1.20263	0.90000
99	-1.73205	1.00000	0.00000	-1.28403	-0.64[illegible]49	0.00000	1.43895	-1.07058	1.00000
100	-2.07846	1.20000	0.00000	-1.21241	-0.53202	0.00000	1.32400	-0.75297	1.20000
101	-2.42487	1.40000	0.00000	-1.15549	-0.43764	0.00000	1.23559	-0.52668	1.40000
102	-2.77128	1.60000	0.00000	-1.12082	-0.35942	0.00000	1.17704	-0.38542	1.60000
103	-3.11769	1.80000	0.00000	-1.09583	-0.30671	0.00000	1.13794	-0.29491	1.80000
104	-3.46410	2.00000	0.00000	-1.07282	-0.26440	0.00000	1.10492	-0.22085	2.00000
105	-3.89711	2.25000	0.00000	-1.05670	-0.21711	0.00000	1.07877	-0.16374	2.25000
106	-4.33013	2.50000	0.00000	-1.05233	-0.17996	0.00000	1.06760	-0.13977	2.50000
107	-4.76314	2.75000	0.00000	-1.05175	-0.15378	0.00000	1.06293	-0.12982	2.75000
108	-5.19615	3.00000	0.00000	-1.05089	-0.13529	0.00000	1.05956	-0.12267	3.00000
109	-5.62917	3.25000	0.00000	-1.04947	-0.12122	0.00000	1.05644	-0.11607	3.25000
110	-6.06218	3.50000	0.00000	-1.04808	-0.10995	0.00000	1.05383	-0.11056	3.50000
111	-6.49519	3.75000	0.00000	-1.04683	-0.10084	0.00000	1.05168	-0.10603	3.75000
112	-6.92820	4.00000	0.00000	-1.04557	-0.09350	0.00000	1.04974	-0.10195	4.00000
113	-7.79423	4.50000	0.00000	-1.04263	-0.08242	0.00000	1.04588	-0.09387	4.50000
114	-8.66025	5.00000	0.00000	-1.03934	-0.07439	0.00000	1.04200	-0.08576	5.00000
115	-1.50000	0.00000	0.00000	-0.08041	0.00000	0.00000	0.08041	0.99353	0.75000
116	-1.60000	0.00000	0.00000	-0.07122	0.00000	0.00000	0.07122	0.99493	0.80000
117	-1.80000	0.00000	0.00000	-0.04429	0.00000	0.00000	0.04429	0.99804	0.90000
118	-2.00000	0.00000	0.00000	0.02986	0.00000	0.00000	0.02986	0.99911	1.00000
119	-2.40000	0.00000	0.00000	-0.77096	0.00000	0.00000	0.77096	0.40561	1.20000
120	-2.80000	0.00000	0.00000	-0.58006	-0.00001	0.00000	0.58006	0.6625[illegible]	1.40000
121	-3.20000	0.00000	0.00000	-0.84641	0.00000	0.00000	0.84641	0.28358	1.60000

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Figure 15.- Continued.

122	-3.60000	0.00000	0.00000	-0.86723	0.00000	0.00000	0.86723	0.24792	1.80000
123	-4.00000	0.00000	0.00000	-0.80054	0.00000	0.00000	0.80054	0.35914	2.00000
124	-4.50000	0.00000	0.00000	-0.83538	0.00000	0.00000	0.83538	0.30214	2.25000
125	-5.00000	0.00000	0.00000	-0.91163	0.00000	0.00000	0.91163	0.16894	2.50000
126	-5.50000	0.00000	0.00000	-0.96395	0.00000	0.00000	0.96395	0.07080	2.75000
127	-6.00000	0.00000	0.00000	-0.97205	0.00000	0.00000	0.97205	0.05511	3.00000
128	-6.50000	0.00000	0.00000	-0.97099	0.00000	0.00000	0.97099	0.05717	3.25000
129	-7.00000	0.00000	0.00000	-0.98126	0.00000	0.00000	0.98126	0.03713	3.50000
130	-7.50000	0.00000	0.00000	-0.99481	0.00000	0.00000	0.99481	0.01035	3.75000
131	-8.00000	0.00000	0.00000	-1.00156	0.00000	0.00000	1.00156	-0.00311	4.00000
132	-9.00000	0.00000	0.00000	-1.00236	0.00000	0.00000	1.00236	-0.00472	4.50000
133	-10.00000	0.00000	0.00000	-1.00475	0.00000	0.00000	1.00475	-0.00953	5.00000

(h) Page 15

VELOCITY RATIO IS OUTSIDE OF RANGE USED IN THE CORRELATION FOR THETA = 60.0 DEGREES

(i) Page 17

Figure 15.- Concluded.

VJ/V0 = 3.9, THETA = 15 DEG. (DELTAJ = 75 DEG.)
CALCULATION TO OBTAIN PRESSURES (INCLUDING CORRELATION
FACTORS) AT PLATE FIELD POINTS

JET PARAMETERS	VJET/VINF	EFFECTIVE VJET/VINF	XQ	YQ	ZQ	NCYL
	3.9000	3.7671	0.0000	0.0000	0.0000	20

XCL	YCL	ZCL	A	P	SCL	THETA
0.00000	0.00000	0.00000	1.00000	6.283	0.000	15.000
0.05400	0.00000	0.20000	1.00000	6.283	0.207	15.021
0.13400	0.00000	0.50000	1.04200	6.547	0.518	15.1[illegible]
0.27200	0.00000	1.00000	1.11300	6.993	1.036	15.748
0.41600	0.00000	1.50000	1.18400	7.439	1.557	16.540
0.56900	0.00000	2.00000	1.25400	7.879	2.080	18.101
0.91700	0.00000	3.00000	1.39400	8.759	3.138	21.058
1.34000	0.00000	4.00000	1.53400	9.638	4.224	25.269
1.86300	0.00000	5.00000	1.67400	10.518	5.353	29.580
2.17000	0.00000	5.50000	1.74400	10.958	5.939	32.961
2.51200	0.00000	6.00000	1.84600	11.599	6.545	36.516
3.31200	0.00000	7.00000	2.05100	12.587	7.826	41.467
4.28700	0.00000	8.00000	2.25600	14.175	9.222	46.961
5.46400	0.00000	9.00000	2.45500	15.425	10.767	52.075
6.86600	0.00000	10.00000	2.64200	16.600	12.489	56.672
8.52000	0.00000	11.00000	2.81600	17.693	14.422	60.277
9.44900	0.00000	11.50000	2.88900	18.152	15.477	62.584
10.45000	0.00000	12.00000	2.95600	18.573	16.596	64.662
12.68200	0.00000	13.00000	3.07900	19.346	19.041	66.921
13.91800	0.00000	13.50000	3.12900	19.660	20.375	67.975

OPTIONS...

NP	NVEL	NOUTA	NOUTB	NOUTC	NOUTD	NFORC
133	0	1	1	1	1	0

ENTRAINMENT MODEL INDUCED VELOCITY FIELD IN PLATE COORDINATE SYSTEM

N	XB	YB	ZB	U/V0	V/V0	W/V0	VT/V0
1	1.50000	0.00000	0.00000	-0.10867	0.00000	0.00000	0.10867
2	1.60000	0.00000	0.00000	-0.10312	0.00000	0.00000	0.10312
3	1.80000	0.00000	0.00000	-0.09370	0.00000	0.00000	0.09370
4	2.00000	0.00000	0.00000	-0.08598	0.00000	0.00000	0.08598
5	2.40000	0.00000	0.00000	-0.07399	0.00000	0.00000	0.07399
6	2.80000	0.00000	0.00000	-0.06502	0.00000	0.00000	0.06502
7	3.20000	0.00000	0.00000	-0.05801	0.00000	0.00000	0.05801
8	3.60000	0.00000	0.00000	-0.05236	0.00000	0.00000	0.05236
9	4.00000	0.00000	0.00000	-0.04765	0.00000	0.00000	0.04765
10	4.50000	0.00000	0.00000	-0.04277	0.00000	0.00000	0.04277
11	5.00000	0.00000	0.00000	-0.03871	0.00000	0.00000	0.03871
12	5.50000	0.00000	0.00000	-0.03529	0.00000	0.00000	0.03529
13	6.00000	0.00000	0.00000	-0.03236	0.00000	0.00000	0.03236
14	6.50000	0.00000	0.00000	-0.02982	0.00000	0.00000	0.02982
15	7.00000	0.00000	0.00000	-0.02759	0.00000	0.00000	0.02759
16	7.50000	0.00000	0.00000	-0.02562	0.00000	0.00000	0.02562
17	8.00000	0.00000	0.00000	-0.02388	0.00000	0.00000	0.02388
18	9.00000	0.00000	0.00000	-0.02091	0.00000	0.00000	0.02091
19	10.00000	0.00000	0.00000	-0.01848	0.00000	0.00000	0.01848
20	1.29904	0.75000	0.00000	-0.10157	-0.03833	0.00000	0.10856
21	1.38564	0.80000	0.00000	-0.09644	-0.03719	0.00000	0.10336
22	1.55885	0.90000	0.00000	-0.08773	-0.03374	0.00000	0.09399
23	1.73205	1.00000	0.00000	-0.08058	-0.03095	0.00000	0.08632
24	2.07846	1.20000	0.00000	-0.06946	-0.02667	0.00000	0.07441

(a) Page 1

Figure 16.- Output from Sample case 2.

PREDICTED PRESSURE COEFFICIENTS INDUCED ON A
FLAT PLATE BY A JET ISSUING FROM THE PLATE

VJET/VINF = 3.900
THETA = 15.000 DEG

BETA, DEGREES	R/D	PLATE COORDINATES XB	YB	ZB	CP, THEORETICAL	DELTA CP	CP, CORRELATION
0.00	0.750	1.50000	0.00000	0.00000	0.52048	-0.07999	0.44049
0.00	0.800	1.60000	0.00000	0.00000	0.45805	-0.06019	0.39786
0.00	0.900	1.80000	0.00000	0.00000	0.35905	-0.02059	0.33846
0.00	1.000	2.00000	0.00000	0.00000	0.28590	0.01901	0.30491
0.00	1.200	2.40000	0.00000	0.00000	0.18896	0.02221	0.21119
0.00	1.400	2.80000	0.00000	0.00000	0.13071	0.02541	0.15611
0.00	1.600	3.20000	0.00000	0.00000	0.09362	0.02621	0.11983
0.00	1.800	3.60000	0.00000	0.00000	0.06883	0.02461	0.09344
0.00	2.000	4.00000	0.00000	0.00000	0.05169	0.02301	0.07470
0.00	2.250	4.50000	0.00000	0.00000	0.03693	0.02276	0.05969
0.00	2.500	5.00000	0.00000	0.00000	0.02683	0.02251	0.04934
0.00	2.750	5.50000	0.00000	0.00000	0.01967	0.02226	0.04193
0.00	3.000	6.00000	0.00000	0.00000	0.01447	0.02201	0.03647
0.00	3.250	6.50000	0.00000	0.00000	0.01059	0.02176	0.03235
0.00	3.500	7.00000	0.00000	0.00000	0.00764	0.02151	0.02915
0.00	3.750	7.50000	0.00000	0.00000	0.00537	0.02125	0.02662
0.00	4.000	8.00000	0.00000	0.00000	0.00258	0.02100	0.02458
0.00	4.500	9.00000	0.00000	0.00000	0.00103	0.02050	0.02153
0.00	5.000	10.00000	0.00000	0.00000	-0.00064	0.02000	0.01936
30.00	0.750	1.29904	0.75000	0.00000	0.13503	-0.01099	0.12404
30.00	0.800	1.38564	0.80000	0.00000	0.12297	0.00341	0.12638
30.00	0.900	1.55885	0.90000	0.00000	0.09687	0.03221	0.12908
30.00	1.000	1.73205	1.00000	0.00000	0.07422	0.06101	0.13523
30.00	1.200	2.07846	1.20000	0.00000	0.04162	0.05420	0.09582
30.00	1.400	2.42487	1.40000	0.00000	0.02161	0.04740	0.06901
30.00	1.600	2.77128	1.60000	0.00000	0.00926	0.04280	0.05206
30.00	1.800	3.11769	1.80000	0.00000	0.00159	0.04040	0.04199
30.00	2.000	3.46410	2.00000	0.00000	-0.00326	0.03800	0.03474
30.00	2.250	3.89711	2.25000	0.00000	-0.00693	0.03625	0.02932
30.00	2.500	4.33013	2.50000	0.00000	-0.00900	0.03450	0.02550
30.00	2.750	4.76314	2.75000	0.00000	-0.01015	0.03275	0.02260
30.00	3.000	5.19615	3.00000	0.00000	-0.01073	0.03100	0.02027
30.00	3.250	5.62917	3.25000	0.00000	-0.01098	0.03037	0.01940
30.00	3.500	6.06218	3.50000	0.00000	-0.01101	0.02975	0.01874
30.00	3.750	6.49519	3.75000	0.00000	-0.01091	0.02912	0.01821
30.00	4.000	6.92820	4.00000	0.00000	-0.01074	0.02850	0.01776
30.00	4.500	7.79423	4.50000	0.00000	-0.01028	0.02725	0.01697
30.00	5.000	8.66025	5.00000	0.00000	-0.00978	0.02600	0.01622
60.00	0.750	0.75000	1.29904	0.00000	-0.76207	0.02701	-0.73506
60.00	0.800	0.80000	1.38564	0.00000	-0.66480	0.03301	-0.63179
60.00	0.900	0.90000	1.55885	0.00000	-0.52543	0.04501	-0.48042
60.00	1.000	1.00000	1.73205	0.00000	-0.43098	0.05701	-0.37397
60.00	1.200	1.20000	2.07846	0.00000	-0.31232	0.05380	-0.25852
60.00	1.400	1.40000	2.42487	0.00000	-0.24135	0.05060	-0.19075
60.00	1.600	1.60000	2.77128	0.00000	-0.19442	0.04280	-0.15162
60.00	1.800	1.80000	3.11769	0.00000	-0.16122	0.03040	-0.13082
60.00	2.000	2.00000	3.46410	0.00000	-0.13659	0.01800	-0.11859
60.00	2.250	2.25000	3.89711	0.00000	-0.11359	0.01750	-0.09609
60.00	2.500	2.50000	4.33013	0.00000	-0.09635	0.01700	-0.07935
60.00	2.750	2.75000	4.76314	0.00000	-0.08301	0.01650	-0.06651
60.00	3.000	3.00000	5.19615	0.00000	-0.07242	0.01600	-0.05642
60.00	3.250	3.25000	5.62917	0.00000	-0.06389	0.01475	-0.04914
60.00	3.500	3.50000	6.06218	0.00000	-0.05685	0.01350	-0.04335
60.00	3.750	3.75000	6.49519	0.00000	-0.05098	0.01225	-0.03873
60.00	4.000	4.00000	6.92820	0.00000	-0.04603	0.01100	-0.03503
60.00	4.500	4.50000	7.79423	0.00000	-0.03818	0.00850	-0.02968
60.00	5.000	5.00000	8.66025	0.00000	-0.02982	0.00600	-0.02382

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Figure 16.- Continued.

90.00	0.750	0.00000	1.50000	0.00000	-1.56328	-0.69059	-2.25428
90.00	0.800	0.00000	1.60000	0.00000	-1.36975	-0.60299	-1.97275
90.00	0.900	0.00000	1.80000	0.00000	-1.08205	-0.42699	-1.50904
90.00	1.000	0.00000	2.00000	0.00000	-0.88181	-0.25099	-1.13280
90.00	1.200	0.00000	2.40000	0.00000	-0.62667	-0.20860	-0.83526
90.00	1.400	0.00000	2.80000	0.00000	-0.47437	-0.16620	-0.64057
90.00	1.600	0.00000	3.20000	0.00000	-0.37492	-0.13080	-0.50572
90.00	1.800	0.00000	3.60000	0.00000	-0.30574	-0.10240	-0.40814
90.00	2.000	0.00000	4.00000	0.00000	-0.25529	-0.07400	-0.32929
90.00	2.250	0.00000	4.50000	0.00000	-0.20903	-0.06350	-0.27255
90.00	2.500	0.00000	5.00000	0.00000	-0.17496	-0.05300	-0.22796
90.00	2.750	0.00000	5.50000	0.00000	-0.14897	-0.04250	-0.19147
90.00	3.000	0.00000	6.00000	0.00000	-0.12861	-0.03200	-0.16061
90.00	3.250	0.00000	6.50000	0.00000	-0.11230	-0.03063	-0.14292
90.00	3.500	0.00000	7.00000	0.00000	-0.09899	-0.02925	-0.12824
90.00	3.750	0.00000	7.50000	0.00000	-0.08796	-0.02788	-0.11584
90.00	4.000	0.00000	8.00000	0.00000	-0.07872	-0.02650	-0.10522
90.00	4.500	0.00000	9.90000	0.00000	-0.06412	-0.02375	-0.08787
90.00	5.000	0.00000	10.00000	0.00000	-0.05322	-0.02100	-0.07422
120.00	0.750	-0.75000	1.29904	0.00000	-1.49751	-1.16499	-2.66250
120.00	0.800	-0.80000	1.38564	0.00000	-1.29573	-1.12319	-2.41892
120.00	0.900	-0.90000	1.55885	0.00000	-1.00347	-1.03959	-2.04306
120.00	1.000	-1.00000	1.73205	0.00000	-0.80515	-0.95599	-1.76115
120.00	1.200	-1.20000	2.07846	0.00000	-0.55980	-0.80000	-1.35980
120.00	1.400	-1.40000	2.42487	0.00000	-0.41801	-0.64400	-1.06201
120.00	1.600	-1.60000	2.77128	0.00000	-0.32780	-0.51900	-0.84680
120.00	1.800	-1.80000	3.11769	0.00000	-0.26635	-0.42500	-0.69135
120.00	2.000	-2.00000	3.46410	0.00000	-0.22227	-0.33100	-0.55327
120.00	2.250	-2.25000	3.89711	0.00000	-0.18230	-0.28675	-0.46905
120.00	2.500	-2.50000	4.33013	0.00000	-0.15307	-0.24250	-0.39557
120.00	2.750	-2.75000	4.76314	0.00000	-0.13081	-0.19825	-0.32906
120.00	3.000	-3.00000	5.19615	0.00000	-0.11335	-0.15400	-0.26735
120.00	3.250	-3.25000	5.62917	0.00000	-0.09929	-0.14163	-0.24091
120.00	3.500	-3.50000	6.06218	0.00000	-0.08773	-0.12925	-0.21698
120.00	3.750	-3.75000	6.49519	0.00000	-0.07807	-0.11688	-0.19494
120.00	4.000	-4.00000	6.92820	0.00000	-0.06987	-0.10450	-0.17437
120.00	4.500	-4.50000	7.79423	0.00000	-0.05673	-0.07975	-0.13648
120.00	5.000	-5.00000	8.66025	0.00000	-0.04665	-0.05500	-0.10165
150.00	0.750	-1.29904	0.75000	0.00000	-0.18248	-2.10699	-2.28948
150.00	0.800	-1.38564	0.80000	0.00000	-0.12046	-1.98619	-2.10665
150.00	0.900	-1.55885	0.90000	0.00000	-0.04474	-1.74459	-1.78933
150.00	1.000	-1.73205	1.00000	0.00000	-0.00589	-1.50299	-1.50888
150.00	1.200	-2.07846	1.20000	0.00000	0.02372	-1.21260	-1.18888
150.00	1.400	-2.42487	1.40000	0.00000	0.03111	-0.92220	-0.89109
150.00	1.600	-2.77128	1.60000	0.00000	0.03185	-0.70700	-0.67515
150.00	1.800	-3.11769	1.80000	0.00000	0.02783	-0.56700	-0.53917
150.00	2.000	-3.46410	2.00000	0.00000	0.02436	-0.42700	-0.40264
150.00	2.250	-3.89711	2.25000	0.00000	0.02047	-0.36825	-0.34778
150.00	2.500	-4.33013	2.50000	0.00000	0.01745	-0.30950	-0.29205
150.00	2.750	-4.76314	2.75000	0.00000	0.01526	-0.25075	-0.23549
150.00	3.000	-5.19615	3.00000	0.00000	0.01374	-0.19200	-0.17826
150.00	3.250	-5.62917	3.25000	0.00000	0.01274	-0.17825	-0.16551
150.00	3.500	-6.06218	3.50000	0.00000	0.01217	-0.16450	-0.15233
150.00	3.750	-6.49519	3.75000	0.00000	0.01192	-0.15075	-0.13883
150.00	4.000	-6.92820	4.00000	0.00000	0.01196	-0.13700	-0.12504
150.00	4.500	-7.79423	4.50000	0.00000	0.01257	-0.10950	-0.09693
150.00	5.000	-8.66025	5.00000	0.00000	0.01369	-0.08200	-0.06831
180.00	0.750	-1.50000	0.00000	0.00000	0.82063	-2.82599	-1.99736
180.00	0.800	-1.60000	0.00000	0.00000	0.77569	-2.65359	-1.87790
180.00	0.900	-1.80000	0.00000	0.00000	0.67526	-2.30879	-1.63353
180.00	1.000	-2.00000	0.00000	0.00000	0.58712	-1.96399	-1.37688
180.00	1.200	-2.40000	0.00000	0.00000	0.45275	-1.56200	-1.10924
180.00	1.400	-2.80000	0.00000	0.00000	0.36063	-1.16000	-0.79937
180.00	1.600	-3.20000	0.00000	0.00000	0.29458	-0.87580	-0.58122
180.00	1.800	-3.60000	0.00000	0.00000	0.24556	-0.70940	-0.46384
180.00	2.000	-4.00000	0.00000	0.00000	0.20850	-0.54300	-0.33450

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Figure 16.- Continued.

180.00	2.250	-4.50000	0.00000	0.00000	0.17405	-0.46750	-0.29345
180.00	2.500	-5.00000	0.00000	0.00000	0.14081	-0.39200	-0.24319
180.00	2.750	-5.50000	0.00000	0.00000	0.12992	-0.31650	-0.18658
180.00	3.000	-6.00000	0.00000	0.00000	0.11550	-0.24100	-0.12550
180.00	3.250	-6.50000	0.00000	0.00000	0.10434	-0.22700	-0.12266
180.00	3.500	-7.00000	0.00000	0.00000	0.09561	-0.21300	-0.11739
180.00	3.750	-7.50000	0.00000	0.00000	0.08874	-0.19900	-0.11026
180.00	4.000	-8.00000	0.00000	0.00000	0.08332	-0.18500	-0.10168
180.00	4.500	-9.00000	0.00000	0.00000	0.07562	-0.15700	-0.08138
180.00	5.000	-10.00000	0.00000	0.00000	0.07087	-0.12900	-0.05813

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Figure 16.- Concluded.

VJ/VO = 8.0, THETA = 0 DEG. (DELTAJ = 90 DEG.)
FORCE AND MOMENT CALCULATION

JET PARAMETERS	VJET/VINF	EFFECTIVE VJET/VINF	XQ	YQ	ZQ	NCYL
	8.0000	8.0000	0.0000	0.0000	0.0000	20

XCL	YCL	ZCL	A	P	SCL	THETA
0.00000	0.00000	0.00000	1.00000	6.283	0.000	0.000
0.00100	0.00000	1.00000	1.16000	7.288	1.000	0.229
0.00800	0.00000	2.00000	1.32000	8.294	2.000	0.716
0.02600	0.00000	3.00000	1.47000	9.236	3.000	1.575
0.06300	0.00000	4.00000	1.63000	10.242	4.001	2.748
0.12200	0.00000	5.00000	1.79000	11.247	5.003	4.231
0.21100	0.00000	6.00000	1.95000	12.252	6.007	6.077
0.33500	0.00000	7.00000	2.10000	13.195	7.014	8.219
0.50000	0.00000	8.00000	2.26000	14.200	8.028	10.669
0.71200	0.00000	9.00000	2.40000	15.582	9.050	13.406
0.97700	0.00000	10.00000	2.70000	16.965	10.084	16.371
1.30000	0.00000	11.00000	2.91000	18.284	11.135	19.553
[illegible]	0.00000	12.00000	3.14000	19.729	12.208	22.907
2.14600	0.00000	13.00000	3.39000	21.300	13.308	26.355
2.68000	0.00000	14.00000	3.61000	22.682	14.442	29.868
3.29600	0.00000	15.00000	3.86000	24.253	15.616	33.389
4.00000	0.00000	16.00000	4.10000	25.761	16.839	36.868
4.79800	0.00000	17.00000	4.32000	27.143	18.118	40.241
5.69500	0.00000	18.00000	4.59000	28.840	19.462	43.489
6.69800	0.00000	19.00000	4.87000	30.599	20.878	45.086

FORCE AND MOMENT CALCULATION INPUT

BETA1 = 30.00 DEGREES

R/RO = 3.000 5.000 7.000 9.000 11.000

PRESSURES ARE CALCULATED AT THE FOLLOWING R/D POSITIONS TO OBTAIN THE PREDICTED NORMAL-FORCE AND PITCHING-MOMENT COEFFICIENTS:

1.00000 2.00000 3.00000 4.00000 5.00000

PLATE RADIUS = 5.500 JET DIAMETERS

OPTIONS...

NP	NVEL	NOUTA	NOUTB	NOUTC	NOUTD	NFORC
30	0	0	0	0	0	1

(a) Page 1

Figure 17.- Output for Sample case 3.

ORIGINAL PAGE IS
OF POOR QUALITY

BLOCKAGE MODEL

(1) JET PARAMETERS

NPHI	NPNLS	NDS	NDSI	
20	200	2	2	8
PHI(0)			DSI	
9.00			1.00	2.00

TOTAL JET INDUCED VELOCITY FIELD IN PLATE COORDINATE SYSTEM

N	XB	YB	ZB	U/V0	V/V0	W/V0	VT/V0	CP	R/D
1	1.93185	0.51764	0.00000	-0.99707	0.12080	0.00000	1.00436	-0.00873	1.00000
2	3.86370	1.03528	0.00000	-1.05369	0.02617	0.00000	1.05402	-0.11095	2.00000
3	5.79556	1.55291	0.00000	-1.04376	0.00968	0.00000	1.04391	-0.08954	3.00000
4	7.72741	2.07055	0.00000	-1.03321	0.00440	0.00000	1.03322	-0.06754	4.00000
5	9.65926	2.58819	0.00000	-1.02552	0.00216	0.00000	1.02552	-0.05169	5.00000
6	1.41421	1.41421	0.00000	-1.25069	0.20094	0.00000	1.26673	-0.60460	1.00000
7	2.82843	2.82843	0.00000	-1.12442	0.03051	0.00000	1.12483	-0.26524	2.00000
8	4.24264	4.24264	0.00000	-1.07845	0.00457	0.00000	1.07845	-0.16307	3.00000
9	5.65685	5.65685	0.00000	-1.05434	-0.00211	0.00000	1.05434	-0.11163	4.00000
10	7.07107	7.07107	0.00000	-1.03980	-0.00410	0.00000	1.03981	-0.08120	5.00000
11	0.51764	1.93185	0.00000	-1.46719	-0.03314	0.00000	1.46757	-1.15376	1.00000
12	1.03528	3.86370	0.00000	-1.17703	-0.05745	0.00000	1.17843	-0.38870	2.00000
13	1.55291	5.79556	0.00000	-1.10200	-0.04790	0.00000	1.10304	-0.21669	3.00000
14	2.07055	7.72741	0.00000	-1.06789	-0.03875	0.00000	1.06860	-0.14190	4.00000
15	2.58819	9.65926	0.00000	-1.04856	-0.03164	0.00000	1.04904	-0.10048	5.00000
16	-0.51764	1.93185	0.00000	-1.36143	-0.39191	0.00000	1.41672	-1.00709	1.00000
17	-1.03528	3.86370	0.00000	-1.12332	-0.17559	0.00000	1.13696	-0.29269	2.00000
18	-1.55291	5.79556	0.00000	-1.06692	-0.11481	0.00000	1.07307	-0.15149	3.00000
19	-2.07055	7.72741	0.00000	-1.04243	-0.08499	0.00000	1.04589	-0.09389	4.00000
20	-2.58819	9.65926	0.00000	-1.02887	-0.06658	0.00000	1.03102	-0.06301	5.00000
21	-1.41421	1.41421	0.00000	-0.95719	-0.51668	0.00000	1.08773	-0.18316	1.00000
22	-2.82843	2.82843	0.00000	-0.97293	-0.20604	0.00000	0.99451	0.01096	2.00000
23	-4.24264	4.24264	0.00000	-0.97682	-0.12985	0.00000	0.98541	0.02897	3.00000
24	-5.65685	5.65685	0.00000	-0.97827	-0.09554	0.00000	0.98292	0.03386	4.00000
25	-7.07107	7.07107	0.00000	-0.97924	-0.07522	0.00000	0.98212	0.03543	5.00000
26	-1.93185	0.51764	0.00000	-0.58992	-0.23804	0.00000	0.63614	0.59533	1.00000
27	-3.86370	1.03528	0.00000	-0.84023	-0.09223	0.00000	0.84527	0.28551	2.00000
28	-5.79556	1.55291	0.00000	-0.89688	-0.05784	0.00000	0.89875	0.19225	3.00000
29	-7.72741	2.07055	0.00000	-0.92010	-0.04282	0.00000	0.92110	0.15157	4.00000
30	-9.65926	2.58819	0.00000	-0.93306	-0.03406	0.00000	0.93368	0.12824	5.00000

(b) Page 2

Figure 17.- Continued.

PREDICTED PRESSURE COEFFICIENTS INDUCED ON A
FLAT PLATE BY A JET ISSUING FROM THE PLATE

VJET/VINF = 8.000
THETA = 0.000 DEG

BETA, DEGREES	R/D	PLATE COORDINATES XB	YB	ZB	CP, THEORETICAL	DELTA CP	CP, CORRELATION
15.00	1.000	1.93185	0.51764	0.00000	-0.00873	-0.03550	-0.04423
15.00	2.000	3.86370	1.03528	0.00000	-0.11095	-0.05200	-0.16295
15.00	3.000	5.79556	1.55291	0.00000	-0.08954	-0.04050	-0.13004
15.00	4.000	7.72741	2.07055	0.00000	-0.06754	-0.02550	-0.09304
15.00	5.000	9.65926	2.58819	0.00000	-0.05169	-0.01050	-0.06219
45.00	1.000	1.41421	1.41421	0.00000	-0.60460	-0.11800	-0.72260
45.00	2.000	2.82843	2.82843	0.00000	-0.26524	-0.11600	-0.38124
45.00	3.000	4.24264	4.24264	0.00000	-0.16307	-0.07850	-0.24157
45.00	4.000	5.65685	5.65685	0.00000	-0.11163	-0.06125	-0.17288
45.00	5.000	7.07107	7.07107	0.00000	-0.08120	-0.04400	-0.12520
75.00	1.000	0.51764	1.93185	0.00000	-1.15376	-0.30150	-1.45526
75.00	2.000	1.03528	3.86370	0.00000	-0.38870	-0.23800	-0.62670
75.00	3.000	1.55291	5.79556	0.00000	-0.21669	-0.17550	-0.39219
75.00	4.000	2.07055	7.72741	0.00000	-0.14190	-0.13625	-0.27815
75.00	5.000	2.58819	9.65926	0.00000	-0.10048	-0.09700	-0.19748
105.00	1.000	-0.51764	1.93185	0.00000	-1.00709	-0.43250	-1.43959
105.00	2.000	-1.03528	3.86370	0.00000	-0.29269	-0.33900	-0.63169
105.00	3.000	-1.55291	5.79556	0.00000	-0.15149	-0.25300	-0.40449
105.00	4.000	-2.07055	7.72741	0.00000	-0.09389	-0.19975	-0.29364
105.00	5.000	-2.58819	9.65926	0.00000	-0.06301	-0.14650	-0.20951
135.00	1.000	-1.41421	1.41421	0.00000	-0.18316	-0.75750	-0.94066
135.00	2.000	-2.82843	2.82843	0.00000	0.01096	-0.40600	-0.39504
135.00	3.000	-4.24264	4.24264	0.00000	0.02897	-0.26200	-0.23303
135.00	4.000	-5.65685	5.65685	0.00000	0.03386	-0.20550	-0.17164
135.00	5.000	-7.07107	7.07107	0.00000	0.03543	-0.14900	-0.11357
165.00	1.000	-1.93185	0.51764	0.00000	0.59533	-1.19500	-0.59967
165.00	2.000	-3.86370	1.03528	0.00000	0.28551	-0.48150	-0.19599
165.00	3.000	-5.79556	1.55291	0.00000	0.19225	-0.29850	-0.10625
165.00	4.000	-7.72741	2.07055	0.00000	0.15157	-0.22550	-0.07393
165.00	5.000	-9.65926	2.58819	0.00000	0.12824	-0.15250	-0.02426

(c) Page 3

PREDICTED LOADS INDUCED ON A FINITE CIRCULAR
PLATE BY A JET ISSUING FROM THE PLATE

VJET/VINF = 8.000
THETA = 0.000 DEG

PLATE AREA = 380.133
REF LENGTH = 11.000

NORMAL-FORCE COEFFICIENT = 0.24800
PITCHING-MOMENT COEFFICIENT = 0.00133

(d) Page 4

Figure 17.- Concluded.

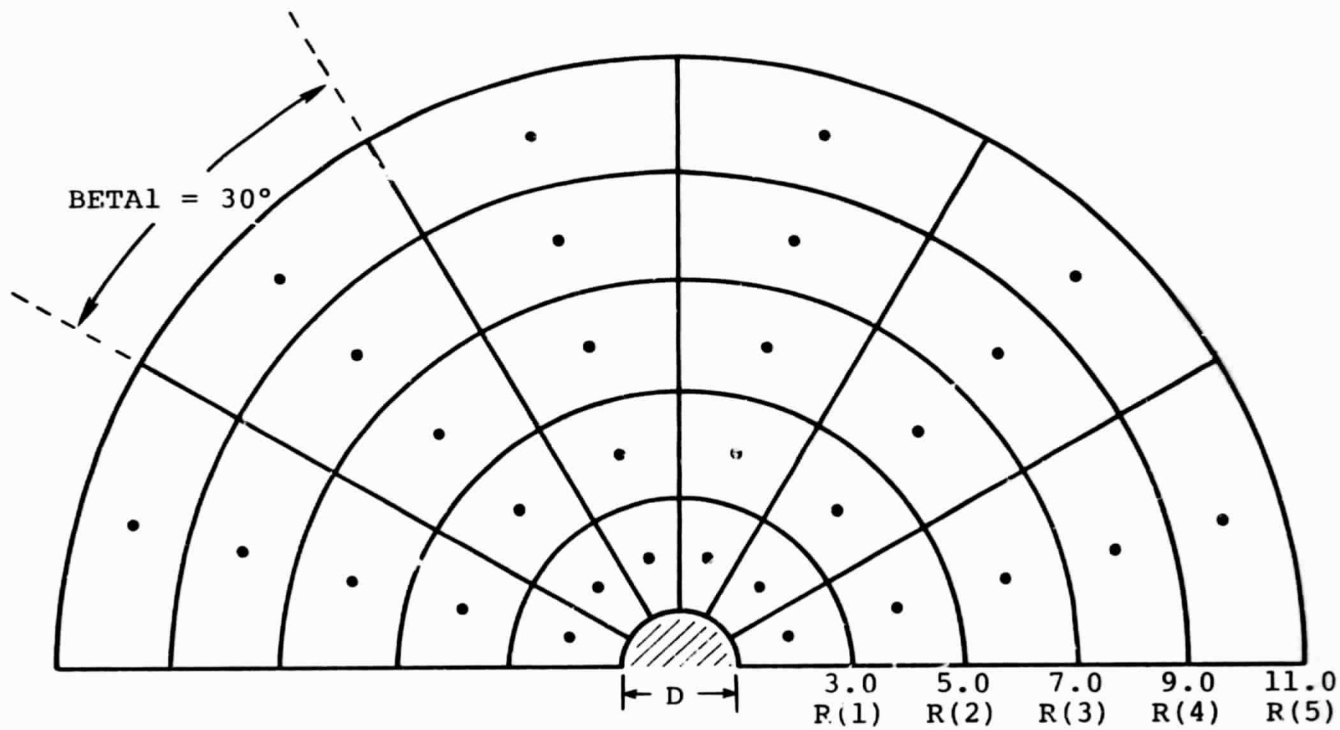


Figure 18.- Field point and area segment layout on a finite circular plate for Sample Case 3.

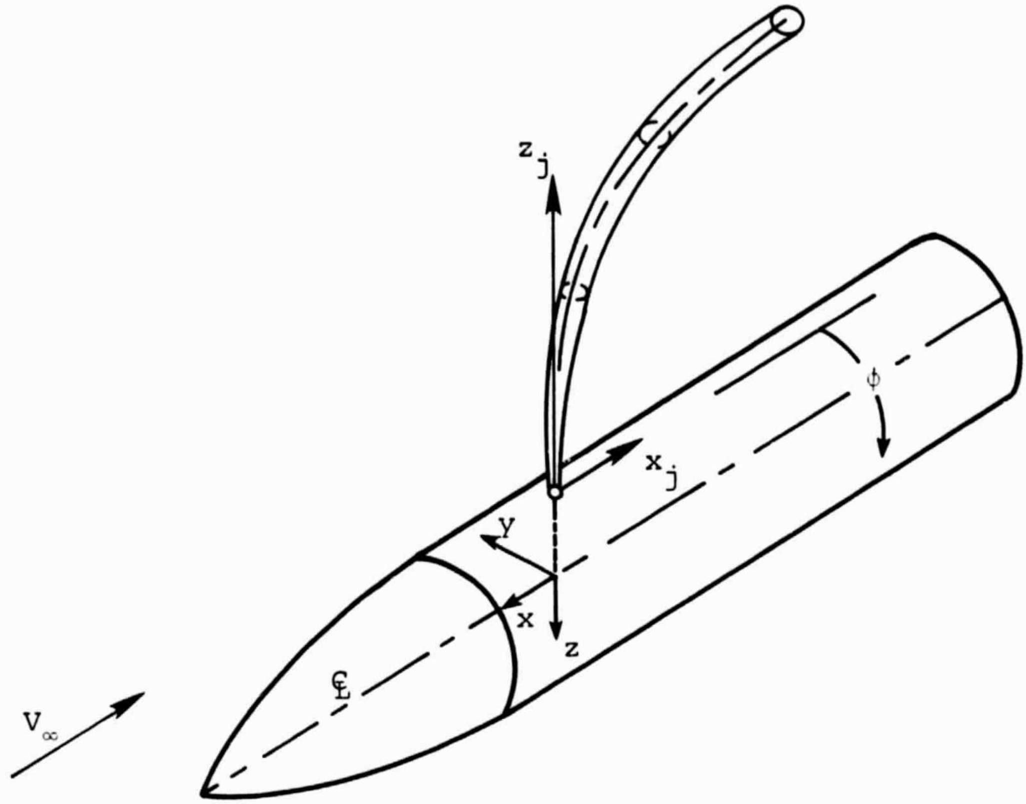


Figure 19.- Coordinate systems for a jet exhausting from the top of a body of revolution into a subsonic crossflow.

```
PROGRAM
JETBOD

    |--JET
    |--ENTRAN   ----SINTGX  ----SADIF
    |              |--SINTGY  ----SADIF
    |              |--SINTGZ  ----SADIF
    |              |--SIMP1   ----FUN
    |--JETBLK   ----JGEOM   ----CLPT
    |                          |--INRAD   ----INVER2
    |                          |--CNRPT   ----TMXSR
    |                          |--QCPQN
    |--FIX

PROGRAM
  END
```

Figure 20.- Subroutine calling sequence for Program JETBOD.

SUBROUTINE NAME / EXTERNAL REFERENCES	CLPT	CNRPT	DELCP	ENTRAN	FIX	INRAD	INVER2	JET	JETBLK	JETBOD	JGEOM	QCPQN	SADIF	SIMP1	SINTGX	SINTGY	SINTGZ	TMXSR
CLPT											X							
CNRPT											X							
ENTRAN										X								
FIX										X								
FUN														X				
INRAD											X							
INVER2						X												
JET										X								
JETBLK										X								
JGEOM									X									
QCPQN											X							
SADIF															X	X	X	
SIMP1				X														
SINTGX				X														
SINTGY				X														
SINTGZ				X														
TMXSR		X																

Figure 21.- Subroutine cross reference table for Program JETBOD.

SUBROUTINE NAME / COMMON BLOCKS	CLPT	CNRPT	DELCP	ENTRAN	FIX	INRAD	INVER2	JET	JETBLK	JETBOD	JGEOM	QCPQN	SADIF	SIMP1	SINTGX	SINTGY	SINTGZ	TMXSR
ANGLD		X							X			X						X
CLDATA	X	X				X												X
CLDIV		X							X									
CONST		X		X				X	X	X								
CP					X													
CPSTR				X						X								
EXP										X								
FIXIT			X		X													
FIXOPT								X		X								
FORC										X								
GEOM					X					X								
INFLMT						X												
MATX		X																X
NDEX									X		X	X						X
NOPT								X	X	X								
PRSTR				X														
QDRDTA		X							X		X	X						X
XYZCL	X	X		X		X		X	X	X								X
YEH				X									X		X	X	X	

Figure 22.- Common block cross reference table for Program JETBOD.

Item		Fields (end column)	
(1)		NHEAD (5), NJET (10), NFIX (15)	
(2)		TITLE (80)	
(3)	+	GAM(J) (10), XQ(J) (20), YQ(J) (30), ZO(J) (40), THETA(J,1) (50), NCYL(J) (55)	
(4)	+	XCLR(J,N) (10), YXLR(J,N) (20), ZCLR(J,N) (30), AJET(J,N) (40)	Set of NCYL(J) cards
(5)	o	AJET(J,1) (10)	
(6)		NP (5), NVEL (10), NSAVE (15), NOUTA (20), NOUTB (25), NOUTD (30), NFPTS (35), NCPBOD (40)	
(7)	x+	XP(J) (10), YP(J) (20), ZP(J) (30)	Set of NP cards
(8)	*	XP(J), YP(J), ZP(J), CP(J)	Unformatted set of input (J = 1,NP)

[+] Omit Items 3, 4, and 7 if NFIX = 1

[*] Omit Item 8 if NFIX = 0, input via unit 25 when NFIX = 1

[x] Item 7 is input via unit 3(unformatted) if NFPTS = 1

[o] Omit item 5 if NFIX = 0

(a) Page 1

Figure 23.- Input forms for Program JETBOD.

Item		5	10					
(9)	+	NFRST	NLAST					

Item		5	10	15	20	25	30	35	
(10)	*	NPHI(NJ)	NDS (NJ)	NDSI(NJ,1)	NDSI(NJ,2)	NDSI(NJ,3)	NDSI(NJ,4)	NDSI(NJ,5)	NDS(NJ) values of NDSI(NJ,NK)

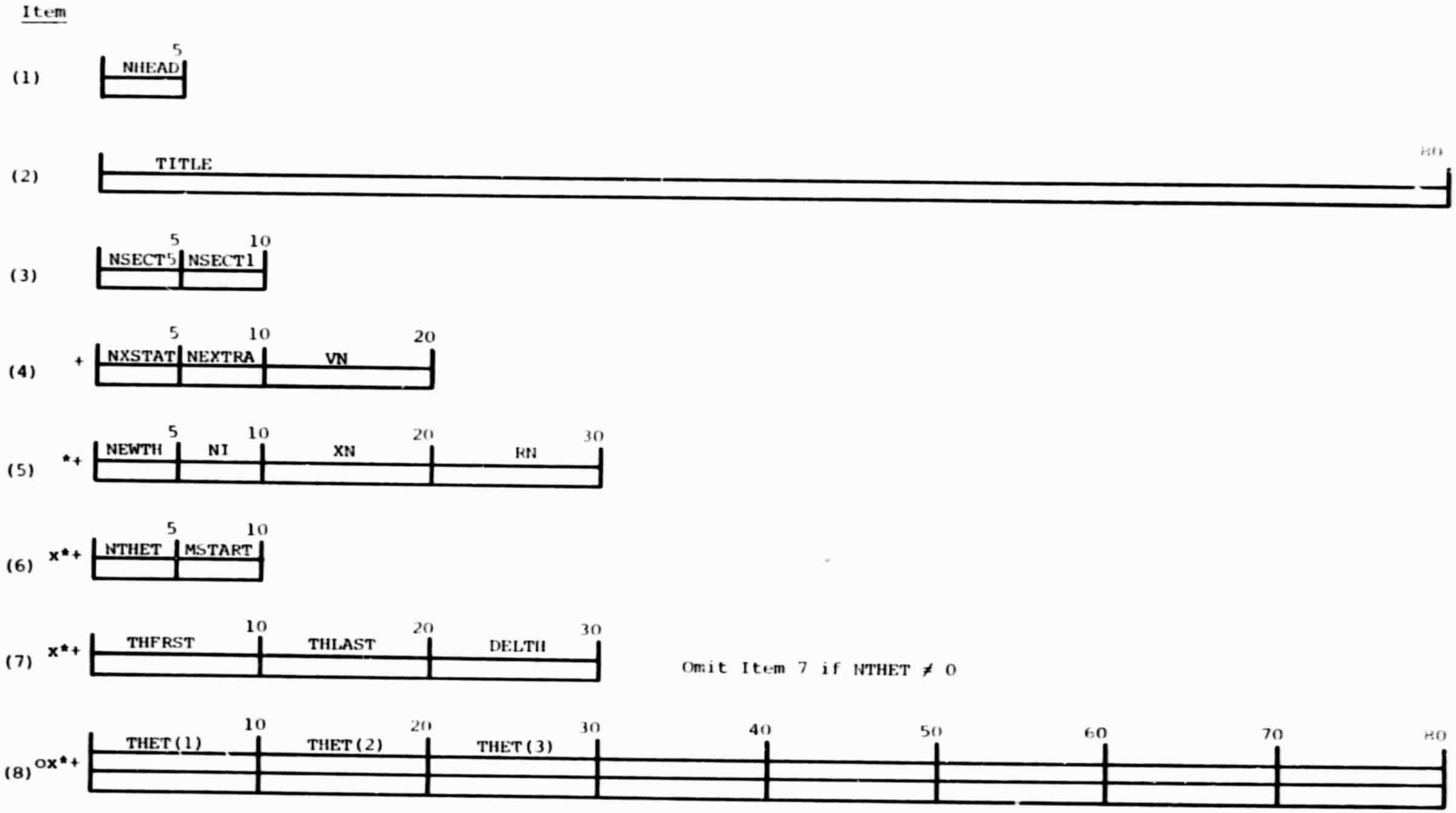
Item		10	20	30	40	50	60	
(11)	*	PHIO(NJ)	DSI(NJ,1)	DSI(NJ,2)	DSI(NJ,3)	DSI(NJ,4)	DSI(NJ,5)	NDS(NJ) values of DSI(NJ,NK)

+Omit Item 9 if NCPBOD = 0 or NVEL = 2

*Omit Items 10 and 11 if NFIX = 1 or NVEL = 1

(b) Page 2

Figure 23.- Concluded.



+Items 4 through 9 are repeated NSECT5 number of times

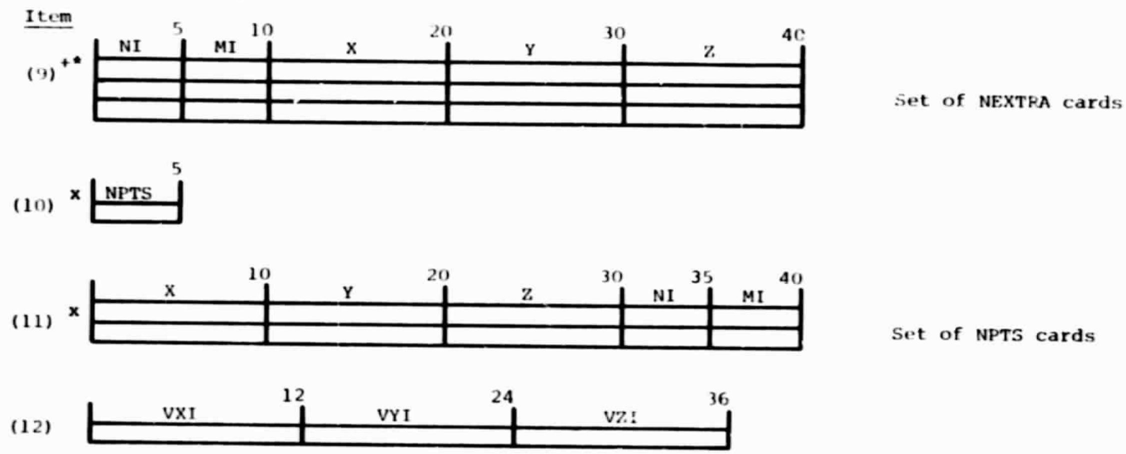
*Items 5 through 8 are repeated NXSTAT number of times

xOmit Items 6, 7, and 8 if NEWTH = 0

oOmit Item 8 if NTHET = 0

(a) Page 1

Figure 24.- Input forms for Program GENBOD.



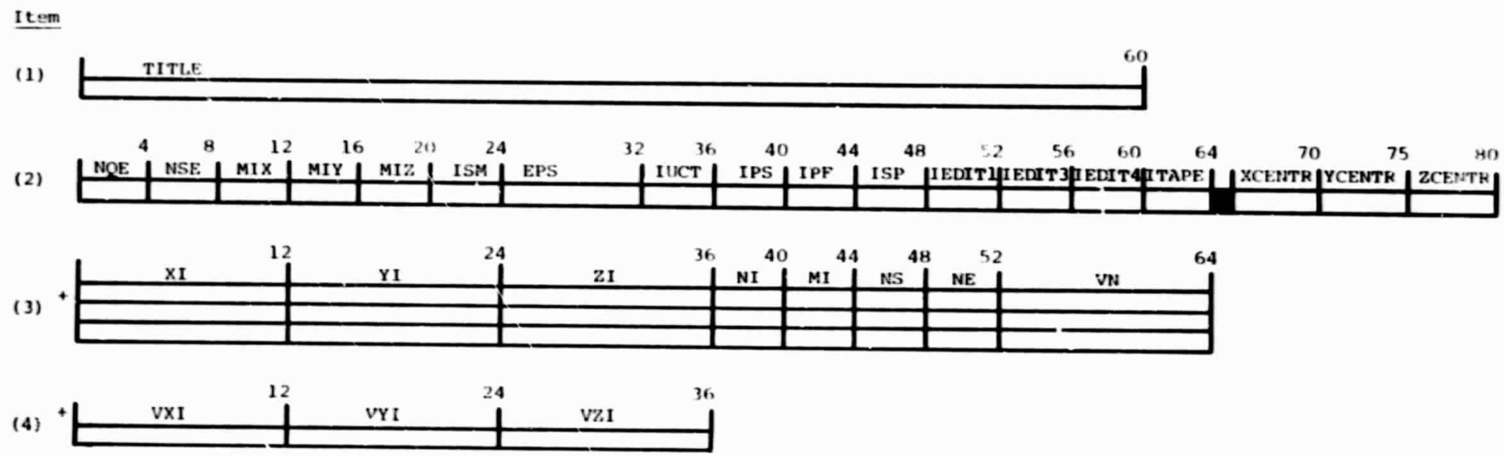
+Items 4 through 9 are repeated NSECT5 number of times

*Omit Item 9 if NEXTRA = 0

xItems 10 and 11 are repeated NSECT1 number of times, omit if NSECT1 = 0

(b) Page 2

Figure 24.- Concluded.



+ Items 3 and 4 are input via unit 50 if ITAPE = 1

Figure 25.- Input forms for Program PFP1.

Item	4	8
(1)	IJET	IEDIT3

(a) Program PFP3

Item	4	8	12	16
(1)	IJET	IEDIT4	IFLOW	IFORCE

Item	12	24	36	
(2)+	U(I)	V(I)	W(I)	Set of IFLOW cards

+Omit Item 2 if IFLOW = 0 (Recommended value)

(b) Program PFP4

Figure 26.- Input forms for Programs PFP3 and PFP4.

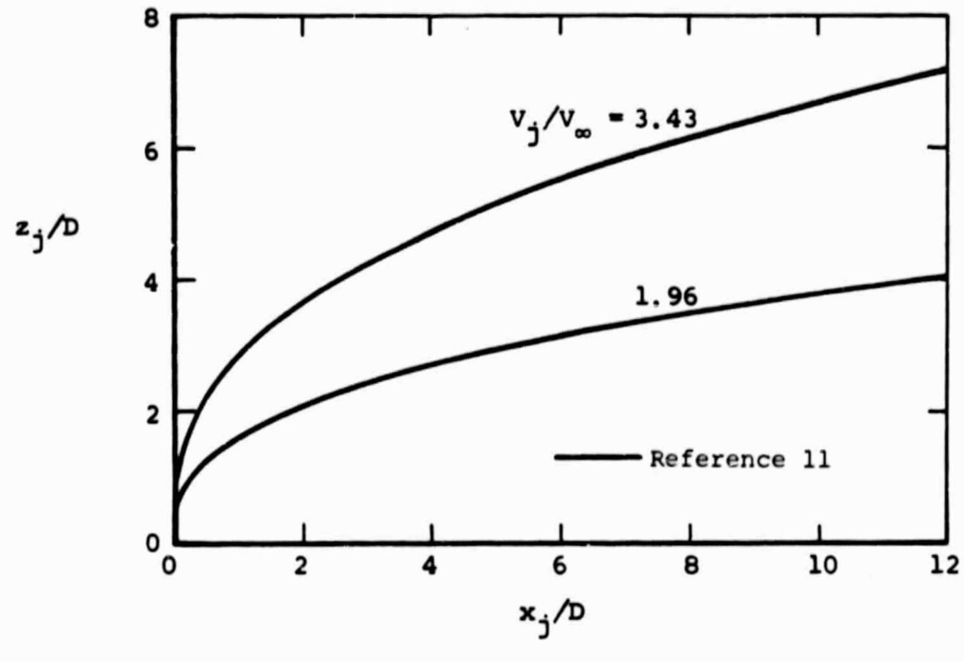


Figure 27.- Centerline shapes for a jet exhausting normal to the surface of a body of revolution.

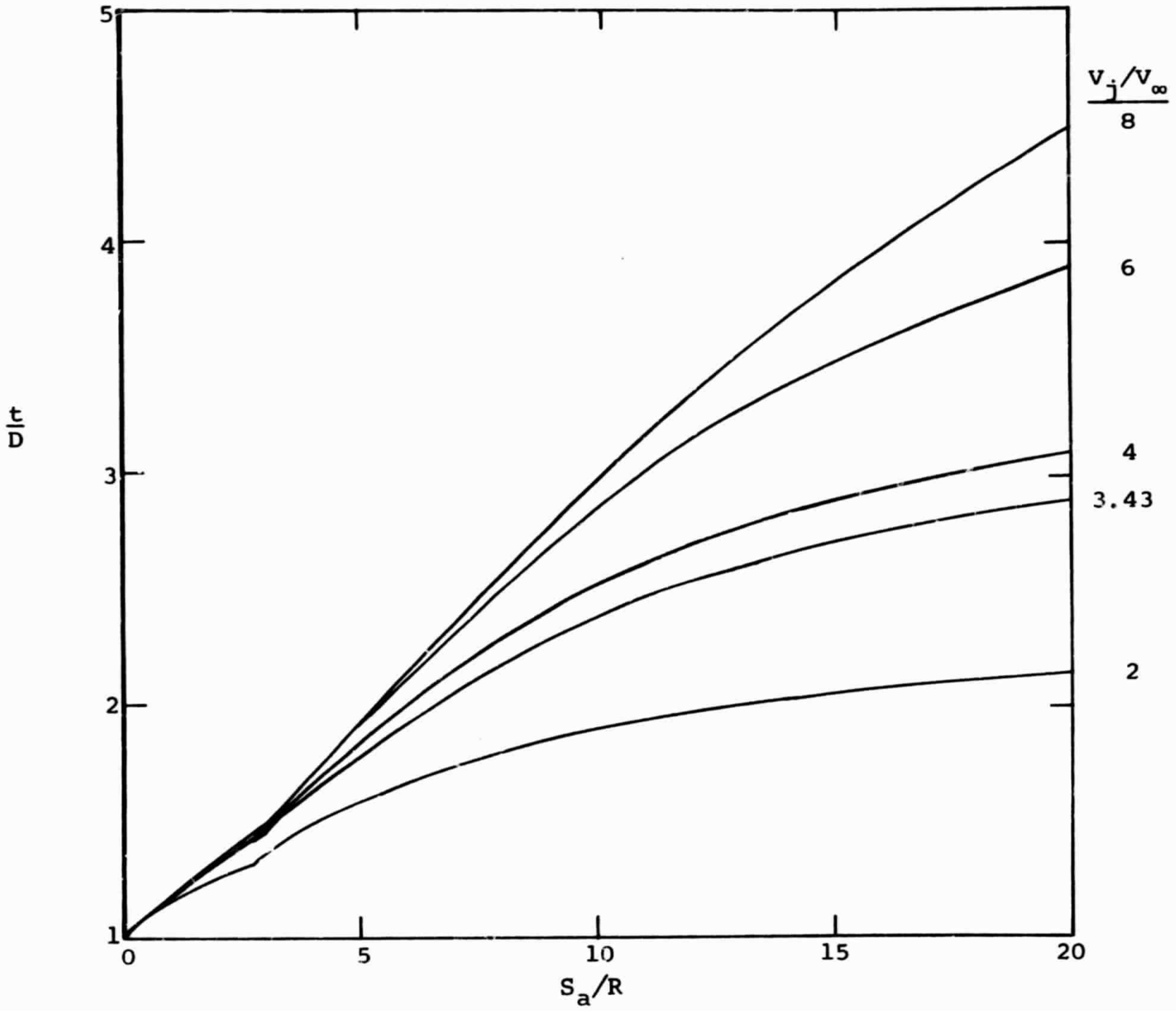


Figure 28.- Jet expansion curves for a jet exhausting normal to the surface of a body of revolution, $\theta = 0°$.

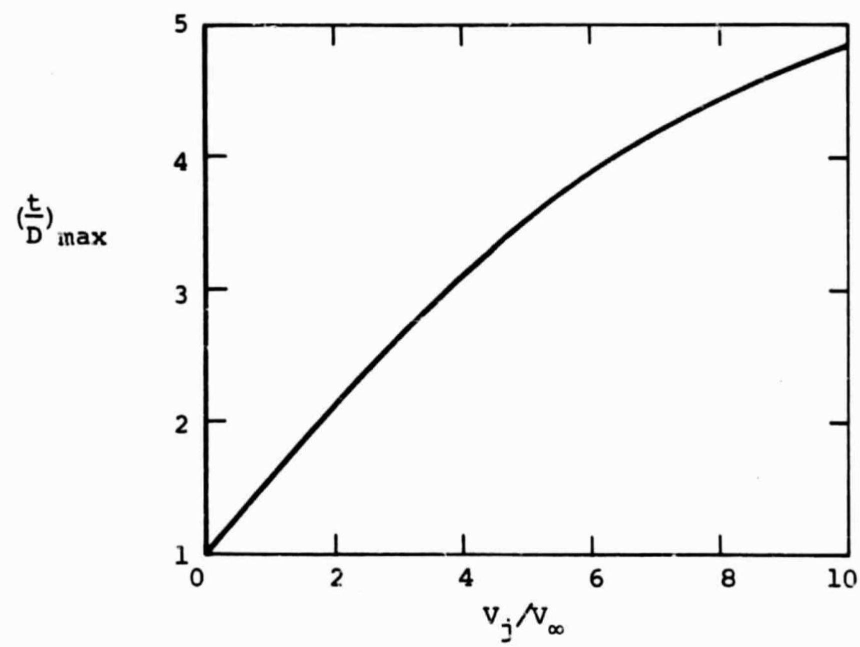


Figure 29.- Maximum jet thickness variation with jet velocity ratio for a jet exhausting normal to the surface of a body of revolution, $S_a/R = 20$.

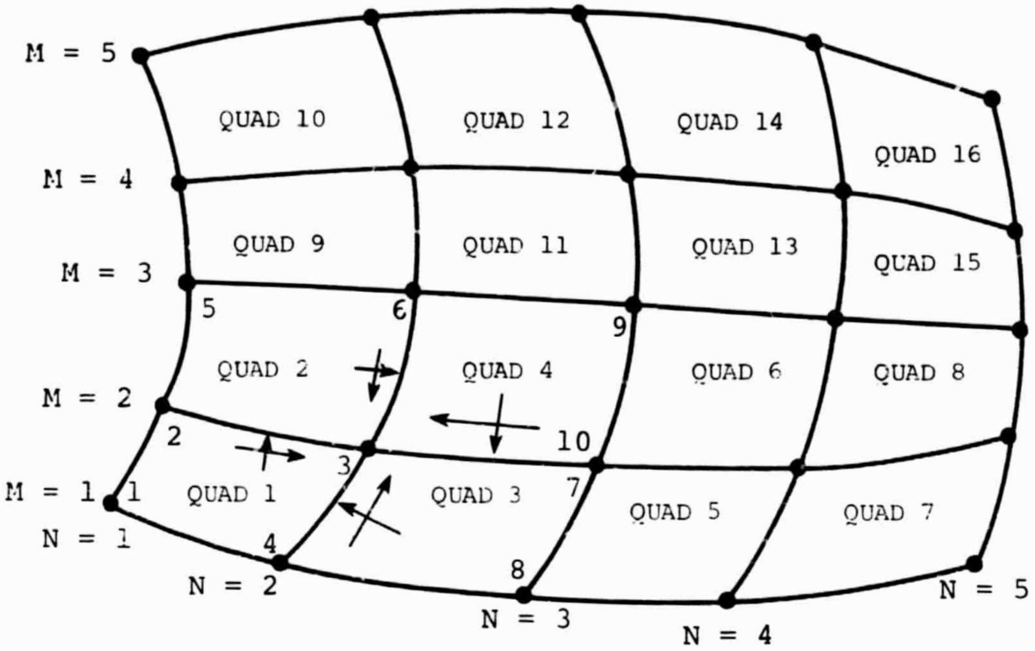


Figure 30.- Ordering of quadrilaterals for modeling the body surface.

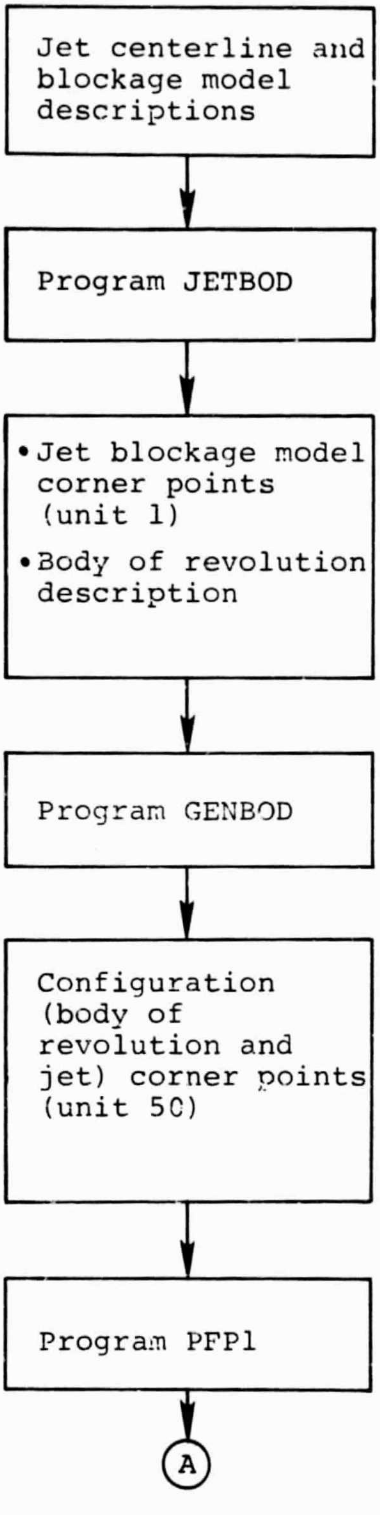


Figure 31.- General flow diagram showing interaction between Program JETBOD and the potential flow programs.

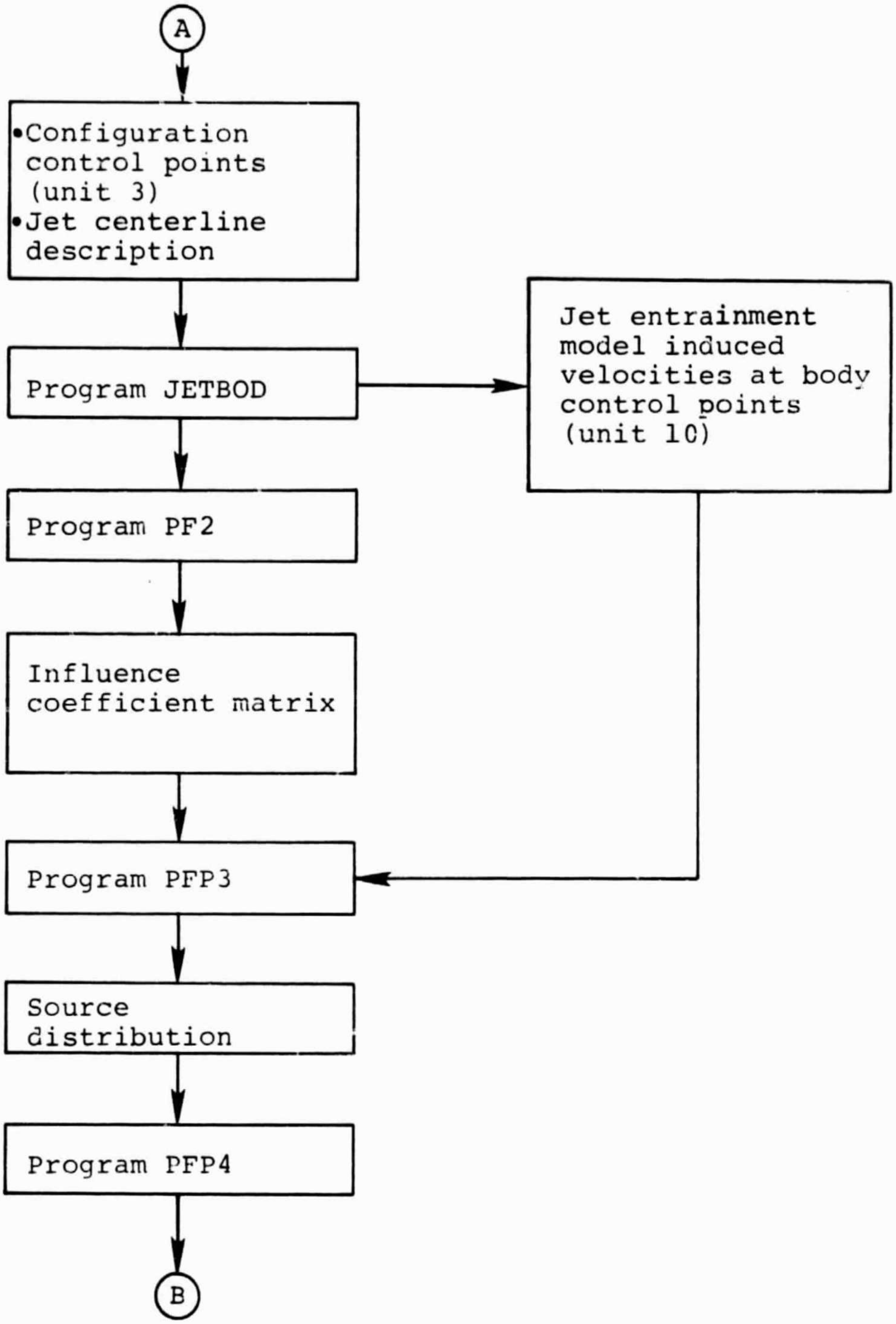


Figure 31.- Continued.

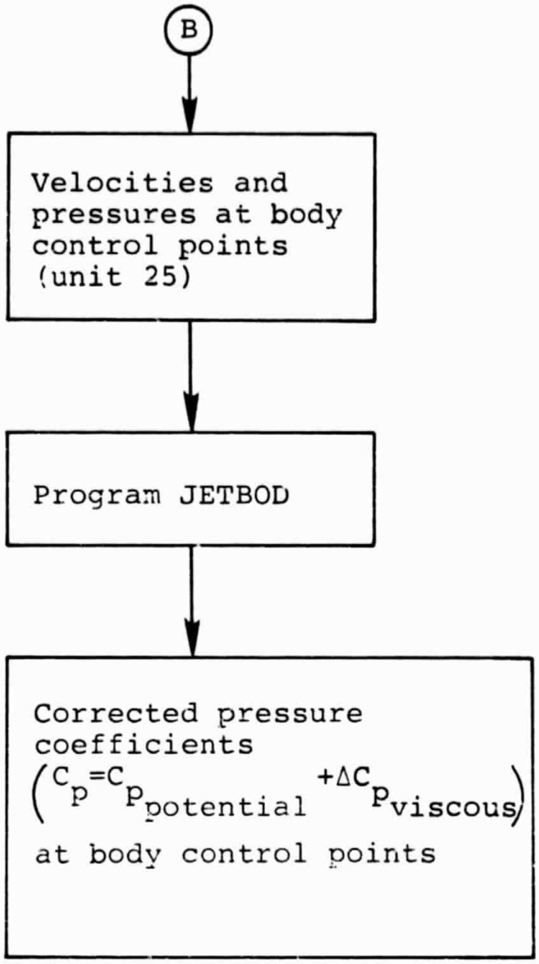


Figure 31.- Concluded.

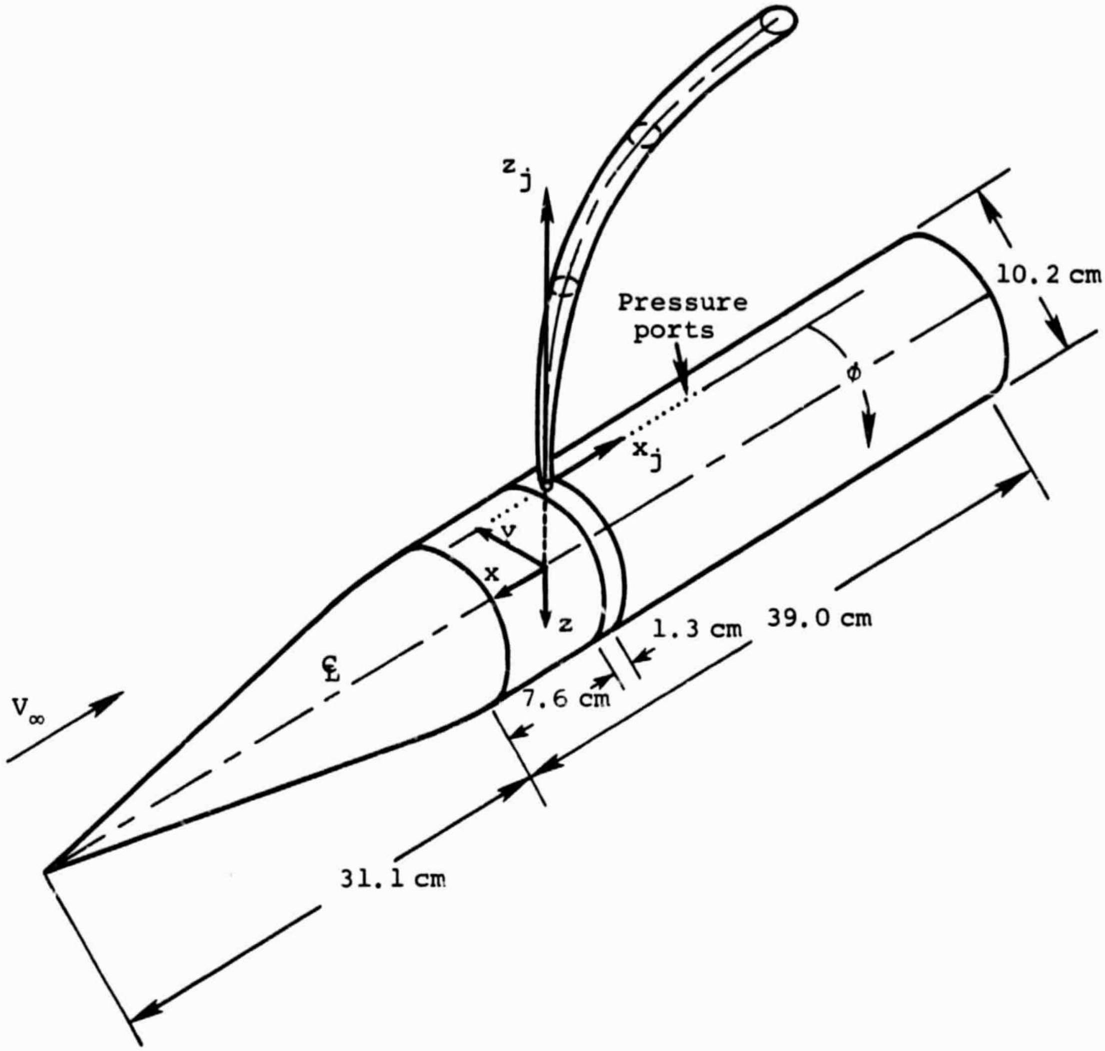


Figure 32.- Cone-cylinder model of reference 12 with jet exhausting from top of body.

Item

```
 1      2    1    0
 2    JET EXHAUSTING FROM CONE-CYLINDER,  VJ/VO = 3.43
      CALCULATION OF JET BLOCKAGE MODEL CORNER POINTS
 3      3.43       0.0        0.0        -5.08       0.0       24
 4    0.000       0.0        0.0         .32
       .007       0.0        .32         .37
       .020       0.0        .48         .395
       .042       0.0        .64         .419
       .076       0.0        .80         .442
       .123       0.0        .96         .464
       .186       0.0        1.12        .486
       .265       0.0        1.28        .508
       .362       0.0        1.44        .529
       .478       0.0        1.60        .551
       .615       0.0        1.76        .573
       .775       0.0        1.92        .605
       .958       0.0        2.08        .639
      1.166       0.0        2.24        .676
      1.400       0.0        2.40        .712
      1.661       0.0        2.56        .742
      1.951       0.0        2.72        .776
      2.270       0.0        2.88        .811
      2.619       0.0        3.04        .842
      3.001       0.0        3.20        .870
      3.415       0.0        3.36        .894
      3.863       0.0        3.52        .917
      4.346       0.0        3.68        .935
      4.865       0.0        3.84        .954
 6      0    2    0    1    0    0    0    0
10     20    2    2    8
11    0.0        .32        .64
```

(a) Program JETBOD, calculation of jet blockage model corner points

Figure 33.- Sample input decks for Program JETBOD and programs making up the potential flow code.

Item

```
1     4
2    NASA CR-2089 CONE-CYLINDER MODEL WITH JET
     100 PANELS ON JET, 532 PANELS ON BODY
     ORIGIN OF COORDINATE SYSTEM AT CENTER OF JET ON BODY AXIS
      WITH X FORWARD, Z DOWN, AND Y TO RIGHT WHEN VIEWED FROM REAR
3     4   1
4     7   0   0.0
5     1   1  39.0      0.057
6     0   1
7    0.0    180.0     15.0
5     0   2  35.0      0.711
      0   3  30.0      1.528
      0   4  25.0      2.345
      0   5  20.0      3.162
      0   6  15.0      3.979
      0   7   6.25     5.080
4    11   0   0.0
5     1   1   8.25     5.08
6    15   1
8    0.0      30.0     45.0     60.0     75.0     90.0    105.0    120.0
    135.0    150.0    162.5    167.5    172.5    177.5    180.0
5     0   2   5.0      5.08
      0   3   4.0      5.08
      0   4   3.5      5.08
      0   5   3.0      5.08
      0   6   2.4      5.08
      0   7   1.44     5.08
      0   8   1.12     5.08
      0   9   0.8      5.08
      0  10   0.48     5.08
      0  11   0.320    5.08
4     9   9   0.0
5     1   1   0.320    5.08
6    12   1
8    0.0      20.0     40.0     60.0     80.0    100.0    120.0    130.0
    140.0    150.0    160.0    170.0
```

(b) Program GENBOD

Figure 33.- Continued.

Item								
5	0	2	0.259	5.08				
	0	3	0.188	5.08				
	0	4	0.099	5.08				
	0	5	0.0	5.08				
	0	6	-0.099	5.08				
	0	7	-0.188	5.08				
	0	8	-0.259	5.08				
	0	9	-0.320	5.08				
9	1	13	0.320	0.0	-5.080			
	2	13	0.259	-0.188	-5.077			
	3	13	0.188	-0.259	-5.073			
	4	13	0.099	-0.304	-5.071			
	5	13	0.0	-0.320	-5.070			
	6	13	-0.099	-0.304	-5.071			
	7	13	-0.188	-0.259	-5.073			
	8	13	-0.259	-0.188	-5.077			
	9	13	-0.320	0.0	-5.080			
4	17	0	0.0					
5	1	1	-0.320	5.08				
6	15	1						
8	0.0	30.0	45.0	60.0	75.0	90.0	105.0	120.0
	135.0	150.0	162.5	167.5	172.5	177.5	180.0	
5	0	2	-0.48	5.08				
	0	3	-0.80	5.08				
	0	4	-1.12	5.08				
	0	5	-1.44	5.08				
	0	6	-2.40	5.08				
	0	7	-3.0	5.08				
	0	8	-3.50	5.08				
	0	9	-4.0	5.08				
	0	10	-5.0	5.08				
	0	11	-6.0	5.08				
	0	12	-8.0	5.08				
	0	13	-10.0	5.08				
	0	14	-15.0	5.08				
	0	15	-20.0	5.08				
	0	16	-25.0	5.08				
	0	17	-30.75	5.08				
12	-1.0	0.0	0.0					

(c) Program GENBOD, concluded

Figure 33.- Continued.

Item

```
1 CONE-CYLINDER MODEL WITH JET- 632 PANELS
2 632    5 150 150 150   1  .0001    0   0   0   0   0   0   0   1
```

(d) Program PFP1

```
1     2     1     0
2 JET EXHAUSTING FROM CONE-CYLINDER,  VJ/VO = 3.43
  CALCULATION OF JET ENTRAINMENT MODEL INDUCED VELOCITIES
3   3.43        0.0         0.0         -5.08       0.0        24
4 0.000        0.0         0.0         .32
   .007        0.0         .32         .37
   .020        0.0         .48         .395
   .042        0.0         .64         .419
   .076        0.0         .80         .442
   .123        0.0         .96         .464
   .186        0.0         1.12        .486
   .265        0.0         1.28        .508
   .362        0.0         1.44        .529
   .478        0.0         1.60        .551
   .615        0.0         1.76        .573
   .775        0.0         1.92        .605
   .958        0.0         2.08        .639
   1.166       0.0         2.24        .676
   1.400       0.0         2.40        .712
   1.661       0.0         2.56        .742
   1.951       0.0         2.72        .776
   2.270       0.0         2.88        .811
   2.619       0.0         3.04        .842
   3.001       0.0         3.20        .870
   3.415       0.0         3.36        .894
   3.863       0.0         3.52        .917
   4.346       0.0         3.68        .935
   4.865       0.0         3.84        .954
6  632    1     1     0     0     0     1  100
9  533  632
```

(e) Program JETBOD, calculation of jet entrainment model induced velocities

Figure 33.- Continued.

```
Item

1     1   0   0
```

(f) Program PFP3

```
1     1   0   0   0
```

(g) Program PFP4

```
1      2    1    1
2   JET EXHAUSTING FROM A CONE-CYLINDER, VJ/VO = 3.43
    VISCOUS CORRELATION FACTORS ADDED TO CP(POTENTIAL)
3     3.43       0.0        0.0        -5.08       0.0        24
5      .32
6    532    0    0    0    0    0    0    0
```

(h) Program JETBOD, determination of corrected pressure coefficients

Figure 33.- Concluded.

JET EXHAUSTING FROM CONE-CYLINDER, VJ/VO = 3.43
CALCULATION OF JET BLOCKAGE MODEL CORNER POINTS

NJET	NFIX
1	0

(1) JET PARAMETERS	VJET/VINF	XQ	YQ	ZQ	NCYL
	3.4300	0.0000	0.0000	-5.0000	24

XCL	YCL	ZCL	A	P	SCL	THETA
0.00000	0.00000	0.00000	0.32000	2.011	0.000	0.000
0.00700	0.00000	0.32000	0.37000	2.325	0.320	2.949
0.02000	0.00000	0.48000	0.39500	2.482	0.481	6.237
0.04200	0.00000	0.64000	0.41900	2.633	0.642	9.913
0.07600	0.00000	0.80000	0.44200	2.777	0.806	14.104
0.12300	0.00000	0.96000	0.46400	2.915	0.972	18.931
0.18600	0.00000	1.12000	0.48600	3.054	1.144	23.085
0.26500	0.00000	1.28000	0.50800	3.192	1.323	28.752
0.36200	0.00000	1.44000	0.52900	3.324	1.510	33.584
0.47800	0.00000	1.60000	0.55100	3.462	1.708	38.257
0.61500	0.00000	1.76000	0.57300	3.600	1.918	42.786
0.77500	0.00000	1.92000	0.60500	3.801	2.144	46.918
0.95800	0.00000	2.08000	[illegible]	4.015	2.388	50.634
1.16600	0.00000	2.24000	[illegible]	4.247	2.650	54.034
1.40000	0.00000	2.40000	[illegible]	4.474	2.933	57.064
1.66100	0.00000	2.56000	0.74200	4.662	3.240	59.802
1.95100	0.00000	2.72000	0.77600	4.876	3.571	62.238
2.27000	0.00000	2.88000	0.81100	5.096	3.928	64.367
2.61900	0.00000	3.04000	0.84200	5.290	4.312	66.322
3.00100	0.00000	3.20000	0.87000	5.466	4.726	68.072
3.41500	0.00000	3.36000	0.89400	5.617	5.170	69.608
3.86300	0.00000	3.52000	0.91700	5.762	5.645	71.009
4.34600	0.00000	3.68000	0.93500	5.875	6.154	72.269
4.86500	0.00000	3.84000	0.95400	5.994	6.697	72.866

OPTIONS...

NP	NVEL	NSAVE	NFPTS	NOUTA	NOUTB	NOUTD	NCPBOD
0	2	0	0	1	0	0	0

(a) Page 1

Figure 34.- Output from Program JETBOD for the sample case, calculation of jet blockage model corner points.

BLOCKAGE MODEL

(1)	JET PARAMETERS	NPHI	NPNLS	NDS	NDSI	
		20	200	2	2	0
		PHI(0)			DSI	
		0.00			0.32	0.64

QUADRILATERAL CORNER POINTS

N	X	Y	Z
1	0.32000	0.00000	-5.08000
2	0.30434	0.09889	-5.08000
3	0.25889	0.18809	-5.08000
4	0.18809	0.25889	-5.08000
5	0.09889	0.30434	-5.08000
6	0.00000	0.32000	-5.08000
7	-0.09889	0.30434	-5.08000
8	-0.18809	0.25889	-5.08000
9	-0.25889	0.18809	-5.08000
10	-0.30434	0.09889	-5.08000
11	-0.32000	0.00000	-5.08000
12	-0.30434	-0.09889	-5.08000
13	-0.25889	-0.18809	-5.08000
14	-0.18809	-0.25889	-5.08000
15	-0.09889	-0.30434	-5.08000
16	0.00000	-0.32000	-5.08000
17	0.09889	-0.30434	-5.08000
18	0.18809	-0.25889	-5.08000
19	0.25889	-0.18809	-5.08000
20	0.30434	-0.09888	-5.08000
21	0.36418	0.00000	-5.44739
22	0.34592	0.11553	-5.44628
23	0.29291	0.21976	-5.44308
24	0.21034	0.30247	-5.43809
25	0.10631	0.35558	-5.43180
26	-0.00902	0.37388	-5.42483
27	-0.12434	0.35556	-5.41785
28	-0.22838	0.30247	-5.41157
29	-0.31094	0.21976	-5.40657
30	-0.36395	0.11553	-5.40337
31	-0.38221	0.00000	-5.40227
32	-0.36395	-0.11554	-5.40337
33	-0.31094	-0.21976	-5.40657
34	-0.22838	-0.30247	-5.41157
35	-0.12434	-0.35558	-5.41785
36	-0.00902	-0.37388	-5.42483
37	0.10631	-0.35558	-5.43180
38	0.21034	-0.30247	-5.43809
39	0.29291	-0.21976	-5.44308
40	0.34592	-0.11553	-5.44628
41	0.36282	0.00000	-5.88119
42	0.34225	0.13272	-5.87687
43	0.28255	0.25244	-5.86434
44	0.18956	0.34746	-5.84481
45	0.07239	0.40846	-5.82021
46	-0.05750	0.42948	-5.79293
47	-0.18738	0.40846	-5.76565
48	-0.30455	0.34746	-5.74105
49	-0.39754	0.25244	-5.72152
50	-0.45724	0.13272	-5.70899
51	-0.47781	0.00000	-5.70467
52	-0.45724	-0.13272	-5.70899
53	-0.39754	-0.25244	-5.72152
54	-0.30455	-0.34746	-5.74105

(b) Page 2

55	-0.18738	-0.40846	-5.76566
56	-0.05750	-0.42948	-5.79293
57	0.07239	-0.40846	-5.82021
58	0.18956	-0.34746	-5.84481
59	0.28255	-0.25244	-5.86434
60	0.34225	-0.13272	-5.87687
61	0.05817	0.00000	-6.84766
62	0.03665	0.16461	-6.83294
63	-0.02580	0.31311	-6.79023
64	-0.12308	0.43097	-6.72369
65	-0.24565	0.50663	-6.63986
66	-0.38152	0.53270	-6.54693
67	-0.51740	0.50663	-6.45400
68	-0.63997	0.43097	-6.37016
69	-0.73724	0.31311	-6.30363
70	-0.79970	0.16461	-6.26091
71	-0.82122	0.00000	-6.24619
72	-0.79970	-0.16461	-6.26091
73	-0.73724	-0.31312	-6.30363
74	-0.63997	-0.43097	-6.37016
75	-0.51740	-0.50663	-6.45400
76	-0.38152	-0.53270	-6.54693
77	-0.24565	-0.50663	-6.63986
78	-0.12308	-0.43097	-6.72370
79	-0.02580	-0.31311	[illegible]9023
80	0.03665	-0.16461	-6.83294
81	-0.50557	0.00000	-7.60209
82	-0.52553	0.19489	-7.57854
83	-0.58344	0.37071	-7.51019
84	-0.67363	0.51024	-7.40374
85	-0.78729	0.59982	-7.26960
86	-0.91328	0.63069	-7.12090
87	-1.03927	0.59982	-6.97220
88	-1.15292	0.51024	-6.83806
89	-1.24312	0.37071	-6.73161
90	-1.30103	0.19489	-6.66326
91	-1.32099	0.00000	-6.63971
92	-1.30103	-0.19489	-6.66326
93	-1.24312	-0.37071	-6.73161
94	-1.15292	-0.51024	-6.83806
95	-1.03927	-0.59982	-6.97220
96	-0.91328	-0.63069	-7.12090
97	-0.78729	-0.59982	-7.26960
98	-0.67363	-0.51024	-7.40374
99	-0.58344	-0.37071	-7.51019
100	-0.52553	-0.19489	-7.57854
101	-1.12669	0.00000	-8.16220
102	-1.14538	0.22387	-8.13207
103	-1.19960	0.42583	-8.04461
104	-1.28406	0.58610	-7.90839
105	-1.39047	0.68901	-7.73675
106	-1.50844	0.72446	-7.54648
107	-1.62640	0.68901	-7.35621
108	-1.73282	0.58610	-7.18456
109	-1.81728	0.42583	-7.04834
110	-1.87150	0.22387	-6.96089
111	-1.89018	0.00000	-6.93075
112	-1.87150	-0.22387	-6.96089
113	-1.81728	-0.42583	-7.04834
114	-1.73282	-0.58610	-7.18456
115	-1.62640	-0.68901	-7.35621
116	-1.50844	-0.72446	-7.54648
117	-1.39047	-0.68901	-7.73675
118	-1.28405	-0.58610	-7.90839
119	-1.19960	-0.42583	-8.04461
120	-1.14538	-0.22387	-8.13207

(c) Page 3

Figure 34.- Continued.

121	-1.76965	0.00000	-8.59862
122	-1.78708	0.24572	-8.56382
123	-1.83764	0.46738	-8.46282
124	-1.91640	0.64330	-8.30552
125	-2.01564	0.75624	-8.10732
126	-2.12565	0.79516	-7.88760
127	-2.23566	0.75624	-7.66788
128	-2.33490	0.64330	-7.46967
129	-2.41365	0.46738	-7.31237
130	-2.46422	0.24572	-7.21138
131	-2.48164	0.00000	-7.17658
132	-2.46422	-0.24572	-7.21138
133	-2.41365	-0.46738	-7.31237
134	-2.33490	-0.64330	-7.46967
135	-2.23566	-0.75624	-7.66788
136	-2.12565	-0.79516	-7.88760
137	-2.01564	-0.75624	-8.10732
138	-1.91640	-0.64330	-8.30553
139	-1.83764	-0.46738	-8.46283
140	-1.76708	-0.24572	-8.56382
141	-2.41624	0.00000	-8.95835
142	-2.43258	0.26316	-8.92000
143	-2.47999	0.50056	-8.80872
144	-2.55384	0.68896	-8.63539
145	-2.64690	0.80993	-8.41699
146	-2.75005	0.85161	-8.17489
147	-2.85320	0.80993	-7.93279
148	-2.94626	0.68896	-7.71439
149	-3.02011	0.50056	-7.54106
150	-3.06752	0.26316	-7.42978
151	-3.08386	0.00000	-7.39143
152	-3.06752	-0.26316	-7.42978
153	-3.02011	-0.50056	-7.54106
154	-2.94626	-0.68896	-7.71439
155	-2.85320	-0.80993	-7.93279
156	-2.75005	-0.85161	-8.17489
157	-2.64690	-0.80992	-8.41699
158	-2.55384	-0.68896	-8.63539
159	-2.47999	-0.50056	-8.80872
160	-2.43258	-0.26316	-8.92000
161	-3.06599	0.00000	-9.26125
162	-3.08130	0.27561	-9.22037
163	-3.12572	0.52424	-9.10173
164	-3.19491	0.72156	-8.91694
165	-3.28209	0.84824	-8.68409
166	-3.37873	0.89190	-8.42598
167	-3.47537	0.84824	-8.16787
168	-3.56255	0.72156	-7.93502
169	-3.63174	0.52424	-7.75023
170	-3.67616	0.27561	-7.63159
171	-3.69147	0.00000	-7.59071
172	-3.67616	-0.27561	-7.63159
173	-3.63174	-0.52424	-7.75023
174	-3.56255	-0.72156	-7.93502
175	-3.47537	-0.84824	-8.16787
176	-3.37873	-0.89190	-8.42598
177	-3.28209	-0.84824	-8.68410
178	-3.19491	-0.72156	-8.91694
179	-3.12572	-0.52424	-9.10173
180	-3.08130	-0.27561	-9.22037
181	-3.71465	0.00000	-9.52258
182	-3.72906	0.28505	-9.47980
183	-3.77087	0.54220	-9.35562
184	-3.83600	0.74627	-9.16222
185	-3.91806	0.87729	-8.91852
186	-4.00902	0.92244	-8.64837

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187	-4.09999	0.67729	-8.37823
188	-4.18205	0.74627	-8.13453
189	-4.24718	0.54220	-7.94112
190	-4.28899	0.28505	-7.81695
191	-4.30340	0.00000	-7.77416
192	-4.28899	-0.28505	-7.81695
193	-4.24718	-0.54220	-7.94112
194	-4.18205	-0.74627	-6.13453
195	-4.09999	-0.87729	-8.37823
196	-4.00902	-0.92244	-8.64837
197	-3.91806	-0.87729	-8.91852
198	-3.83600	-0.74627	-9.16222
199	-3.77087	-0.54220	-9.35562
200	-3.72906	-0.28505	-9.47980
201	-4.35015	0.00000	-9.75068
202	-4.36399	0.29218	-9.70653
203	-4.40416	0.55575	-9.57837
204	-4.46671	0.76493	-9.37877
205	-4.54553	0.89923	-9.12726
206	-4.63291	0.94550	-8.84845
207	-4.72029	0.89923	-8.56964
208	-4.79911	0.76493	-8.31813
209	-4.86167	0.55575	-8.11853
210	-4.90183	0.29218	-7.99038
211	-4.91567	0.00000	-7.94622
212	-4.90183	-0.29218	-7.99038
213	-4.86167	-0.55575	-8.11853
214	-4.79911	-0.76493	-8.31813
215	-4.72029	-0.89923	-8.56965
216	-4.63291	-0.94550	-8.84845
217	-4.54553	-0.89923	-9.12726
218	-4.46671	-0.76493	-9.37877
219	-4.40415	-0.55575	-9.57837
220	-4.36399	-0.29218	-9.70653

(e) Page 5

Figure 34.- Concluded.

```
NASA CR-2089 CONE-CYLINDER MODEL WITH JET
100 PANELS ON JET, 532 PANELS ON BODY
ORIGIN OF COORDINATE SYSTEM AT CENTER OF JET ON BODY AXIS
 WITH X FORWARD, Z DOWN, AND Y TO RIGHT WHEN VIEWED FROM REAR

NO. OF SECTIONS =  5


SECTION  1

     N    X(N)     R(N)       M THETA(M)     Y(M)      Z(M)

     1  39.000    0.057
                              1    0.000     0.000     0.057
                              2   15.000    -0.015     0.055
                              3   30.000    -0.029     0.049
                              4   45.000    -0.040     0.040
                              5   60.000    -0.049     0.028
                              6   75.000    -0.055     0.015
                              7   90.000    -0.057     0.000
                              8  105.000    -0.055    -0.015
                              9  120.000    -0.049    -0.029
                             10  135.000    -0.040    -0.040
                             11  150.000    -0.029    -0.049
                             12  165.000    -0.015    -0.055
                             13  180.000     0.000    -0.057
     2  35.000    0.711
                              1    0.000     0.000     0.711
                              2   15.000    -0.184     0.687
                              3   30.000    -0.356     0.616
                              4   45.000    -0.503     0.503
                              5   60.000    -0.616     0.355
                              6   75.000    -0.687     0.184
                              7   90.000    -0.711     0.000
                              8  105.000    -0.687    -0.184
                              9  120.000    -0.616    -0.356
                             10  135.000    -0.503    -0.503
                             11  150.000    -0.356    -0.616
                             12  165.000    -0.184    -0.687
                             13  180.000     0.000    -0.711
     3  30.000    1.528
                              1    0.000     0.000     1.528
                              2   15.000    -0.395     1.476
                              3   30.000    -0.764     1.323
                              4   45.000    -1.080     1.080
                              5   60.000    -1.323     0.764
                              6   75.000    -1.476     0.395
                              7   90.000    -1.528     0.000
                              8  105.000    -1.476    -0.395
                              9  120.000    -1.323    -0.764
                             10  135.000    -1.080    -1.080
                             11  150.000    -0.764    -1.323
                             12  165.000    -0.395    -1.476
                             13  180.000     0.000    -1.528
     4  25.000    2.345
                              1    0.000     0.000     2.345
                              2   15.000    -0.607     2.265
                              3   30.000    -1.173     2.031
                              4   45.000    -1.658     1.658
                              5   60.000    -2.031     1.172
                              6   75.000    -2.265     0.607
                              7   90.000    -2.345     0.000
                              8  105.000    -2.265    -0.607
```

(a) Page 1

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                              9  120.000    -2.031    -1.173
                             10  135.000    -1.658    -1.658
                             11  150.000    -1.173    -2.031
                             12  165.000    -0.607    -2.265
                             13  180.000     0.000    -2.345
     5  20.000    3.162
                              1    0.000     0.000     3.162
                              2   15.000    -0.818     3.054
                              3   30.000    -1.581     2.738
                              4   45.000    -2.236     2.236
                              5   60.000    -2.738     1.581
                              6   75.000    -3.054     0.818
                              7   90.000    -3.162     0.000
                              8  105.000    -3.054    -0.816
                              9  120.000    -2.738    -1.581
                             10  135.000    -2.236    -2.236
                             11  150.000    -1.581    -2.738
                             12  165.000    -0.818    -3.054
                             13  180.000     0.000    -3.162
     6  15.000    3.979
                              1    0.000     0.000     3.979
                              2   15.000    -1.030     3.843
                              3   30.000    -1.990     3.446
                              4   45.000    -2.814     2.814
                              5   60.000    -3.446     1.989
                              6   75.000    -3.843     1.030
                              7   90.000    -3.979     0.000
                              8  105.000    -3.843    -1.030
                              9  120.000    -3.446    -1.990
                             10  135.000    -2.814    -2.814
                             11  150.000    -1.990    -3.446
                             12  165.000    -1.030    -3.843
                             13  180.000     0.000    -3.979
     7   8.250    5.080
                              1    0.000     0.000     5.080
                              2   15.000    -1.315     4.907
                              3   30.000    -2.540     4.399
                              4   45.000    -3.592     3.592
                              5   60.000    -4.399     2.540
                              6   75.000    -4.907     1.315
                              7   90.000    -5.080     0.000
                              8  105.000    -4.907    -1.315
                              9  120.000    -4.399    -2.540
                             10  135.000    -3.592    -3.592
                             11  150.000    -2.540    -4.399
                             12  165.000    -1.315    -4.907
                             13  180.000     0.000    -5.080


SECTION  2

     N    X(N)     R(N)       M THETA(M)     Y(M)      Z(M)

     1   8.250    5.080
                              1    0.000     0.000     5.080
                              2   30.000    -2.540     4.399
                              3   45.000    -3.592     3.592
                              4   60.000    -4.399     2.540
                              5   75.000    -4.907     1.315
                              6   90.000    -5.080     0.000
                              7  105.000    -4.907    -1.315
                              8  120.000    -4.399    -2.540
                              9  135.000    -3.592    -3.592
                             10  150.000    -2.540    -4.399
                             11  162.500    -1.528    -4.845
```

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Figure 35.- Output from Program GENBOD for the sample case.

			2	20.000	-1.737	4.774
			3	40.000	-3.265	3.892
			4	60.000	-4.399	2.540
			5	80.000	-5.003	0.882
			6	100.000	-5.003	-0.882
			7	120.000	-4.399	-2.540
			8	130.000	-3.892	-3.265
			9	140.000	-3.265	-3.892
			10	150.000	-2.540	-4.399
			11	160.000	-1.737	-4.774
			12	170.000	-0.882	-5.003
9	-0.320	5.080				
			1	0.000	0.000	5.080
			2	20.000	-1.737	4.774
			3	40.000	-3.265	3.892
			4	60.000	-4.399	2.540
			5	80.000	-5.003	0.882
			6	100.000	-5.003	-0.882
			7	120.000	-4.399	-2.540
			8	130.000	-3.892	-3.265
			9	140.000	-3.265	-3.892
			10	150.000	-2.540	-4.399
			11	160.000	-1.737	-4.774
			12	170.000	-0.882	-5.003

EXTRA POINTS

N	M	X	Y	Z
1	13	0.320	0.000	-5.080
2	13	0.259	-0.188	-5.077
3	13	0.188	-0.259	-5.073
4	13	0.099	-0.304	-5.071
5	13	0.000	-0.320	-5.070
6	13	-0.099	-0.304	-5.071
7	13	-0.188	-0.259	-5.073
8	13	-0.259	-0.188	-5.077
9	13	-0.320	0.000	-5.080

SECTION 4

N	X(N)	R(N)	M	THETA(M)	Y(M)	Z(M)
1	-0.320	5.080				
			1	0.000	0.000	5.080
			2	30.000	-2.540	4.399
			3	45.000	-3.592	3.592
			4	60.000	-4.399	2.540
			5	75.000	-4.907	1.315
			6	90.000	-5.080	0.000
			7	105.000	-4.907	-1.315
			8	120.000	-4.399	-2.540
			9	135.000	-3.592	-3.592
			10	150.000	-2.540	-4.399
			11	162.500	-1.528	-4.845
			12	167.500	-1.100	-4.960
			13	172.500	-0.663	-5.037
			14	177.500	-0.222	-5.075
			15	180.000	0.000	-5.080
2	-0.480	5.080				
			1	0.000	0.000	5.080
			2	30.000	-2.540	4.399
			3	45.000	-3.592	3.592
			4	60.000	-4.399	2.540
			5	75.000	-4.907	1.315
			6	90.000	-5.080	0.000

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			13	172.500	-0.663	-5.037
			14	177.500	-0.222	-5.075
			15	180.000	0.000	-5.080
15	-20.000	5.080				
			1	0.000	0.000	5.080
			2	30.000	-2.540	4.399
			3	45.000	-3.592	3.592
			4	60.000	-4.399	2.540
			5	75.000	-4.907	1.315
			6	90.000	-5.080	0.000
			7	105.000	-4.907	-1.315
			8	120.000	-4.399	-2.540
			9	135.000	-3.592	-3.592
			10	150.000	-2.540	-4.399
			11	162.500	-1.528	-4.845
			12	167.500	-1.100	-4.960
			13	172.500	-0.663	-5.037
			14	177.500	-0.222	-5.075
			15	180.000	0.000	-5.080
16	-25.000	5.080				
			1	0.000	0.000	5.080
			2	30.000	-2.540	4.399
			3	45.000	-3.592	3.592
			4	60.000	-4.399	2.540
			5	75.000	-4.907	1.315
			6	90.000	-5.080	0.000
			7	105.000	-4.907	-1.315
			8	120.000	-4.399	-2.540
			9	135.000	-3.592	-3.592
			10	150.000	-2.540	-4.399
			11	162.500	-1.528	-4.845
			12	167.500	-1.100	-4.960
			13	172.500	-0.663	-5.037
			14	177.500	-0.222	-5.075
			15	180.000	0.000	-5.080
17	-30.750	5.080				
			1	0.000	0.000	5.080
			2	30.000	-2.540	4.399
			3	45.000	-3.592	3.592
			4	60.000	-4.399	2.540
			5	75.000	-4.907	1.315
			6	90.000	-5.080	0.000
			7	105.000	-4.907	-1.315
			8	120.000	-4.399	-2.540
			9	135.000	-3.592	-3.592
			10	150.000	-2.540	-4.399
			11	162.500	-1.528	-4.845
			12	167.500	-1.100	-4.960
			13	172.500	-0.663	-5.037
			14	177.500	-0.222	-5.075
			15	180.000	0.000	-5.080

SECTION 5

N	M	X	Y	Z
1	1	0.320	0.000	-5.080
2	1	0.304	-0.099	-5.080
3	1	0.259	-0.188	-5.080
4	1	0.188	-0.259	-5.080
5	1	0.099	-0.304	-5.080
6	1	0.000	-0.320	-5.080
7	1	-0.099	-0.304	-5.080
8	1	-0.188	-0.259	-5.080
9	1	-0.259	-0.188	-5.080

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Figure 35.- Continued.

10	1	-0.304	-0.099	-5.080
11	1	-0.320	0.000	-5.080
1	2	0.364	0.000	-5.447
2	2	0.346	-0.116	-5.446
3	2	0.293	-0.220	-5.443
4	2	0.210	-0.302	-5.438
5	2	0.106	-0.356	-5.432
6	2	-0.009	-0.374	-5.425
7	2	-0.124	-0.356	-5.418
8	2	-0.228	-0.302	-5.412
9	2	-0.311	-0.220	-5.407
10	2	-0.364	-0.116	-5.403
11	2	-0.382	0.000	-5.402
1	3	0.363	0.000	-5.881
2	3	0.342	-0.133	-5.877
3	3	0.283	-0.252	-5.864
4	3	0.190	-0.347	-5.845
5	3	0.072	-0.408	-5.820
6	3	-0.058	-0.429	-5.793
7	3	-0.187	-0.408	-5.766
8	3	-0.305	-0.347	-5.741
9	3	-0.398	-0.252	-5.722
10	3	-0.457	-0.133	-5.709
11	3	-0.478	0.000	-5.705
1	4	0.058	0.000	-6.848
2	4	0.037	-0.165	-6.833
3	4	-0.026	-0.313	-6.790
4	4	-0.123	-0.431	-6.724
5	4	-0.246	-0.507	-6.640
6	4	-0.382	-0.533	-6.54[illegible]
7	4	-0.517	-0.507	-6.45[illegible]
8	4	-0.640	-0.431	-6.370
9	4	-0.737	-0.313	-6.304
10	4	-0.800	-0.165	-6.261
11	4	-0.821	0.000	-6.246
1	5	-0.506	0.000	-7.602
2	5	-0.526	-0.195	-7.579
3	5	-0.583	-0.371	-7.510
4	5	-0.674	-0.510	-7.404
5	5	-0.787	-0.600	-7.270
6	5	-0.913	-0.631	-7.121
7	5	-1.039	-0.600	-6.972
8	5	-1.153	-0.510	-6.838
9	5	-1.243	-0.371	-6.732
10	5	-1.301	-0.195	-6.663
11	5	-1.321	0.000	-6.640
1	6	-1.127	0.000	-8.162
2	6	-1.145	-0.224	-8.132
3	6	-1.200	-0.426	-8.045
4	6	-1.284	-0.586	-7.908
5	6	-1.390	-0.689	-7.737
6	6	-1.508	-0.724	-7.546
7	6	-1.626	-0.689	-7.356
8	6	-1.733	-0.586	-7.185
9	6	-1.817	-0.426	-7.048
10	6	-1.872	-0.224	-6.961
11	6	-1.890	0.000	-6.931
1	7	-1.770	0.000	-8.599
2	7	-1.787	-0.246	-8.564
3	7	-1.838	-0.467	-8.463
4	7	-1.916	-0.643	-8.306
5	7	-2.016	-0.756	-8.107
6	7	-2.126	-0.795	-7.888
7	7	-2.236	-0.756	-7.668
8	7	-2.335	-0.643	-7.470
9	7	-2.414	-0.467	-7.312

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10	7	-2.464	-0.246	-7.211
11	7	-2.482	0.000	-7.177
1	8	-2.416	0.000	-8.958
2	8	-2.433	-0.263	-8.920
3	8	-2.480	-0.501	-8.809
4	8	-2.554	-0.689	-8.635
5	8	-2.647	-0.810	-8.417
6	8	-2.750	-0.852	-8.175
7	8	-2.853	-0.810	-7.933
8	8	-2.946	-0.689	-7.714
9	8	-3.020	-0.501	-7.541
10	8	-3.068	-0.263	-7.430
11	8	-3.084	0.000	-7.391
1	9	-3.066	0.000	-9.261
2	9	-3.081	-0.276	-9.220
3	9	-3.126	-0.524	-9.102
4	9	-3.195	-0.722	-8.917
5	9	-3.282	-0.848	-8.684
6	9	-3.379	-0.892	-8.426
7	9	-3.475	-0.848	-8.168
8	9	-3.563	-0.722	-7.935
9	9	-3.632	-0.524	-7.750
10	9	-3.676	-0.276	-7.632
11	9	-3.691	0.000	-7.591
1	10	-3.715	0.000	-9.523
2	10	-3.729	-0.285	-9.480
3	10	-3.771	-0.542	-9.356
4	10	-3.836	-0.746	-9.162
5	10	-3.918	-0.877	-8.919
6	10	-4.009	-0.922	-8.648
7	10	-4.100	-0.877	-8.378
8	10	-4.182	-0.746	-8.135
9	10	-4.247	-0.542	-7.941
10	10	-4.289	-0.285	-7.817
11	10	-4.303	0.000	-7.774
1	11	-4.350	0.000	-9.751
2	11	-4.364	-0.292	-9.707
3	11	-4.404	-0.556	-9.578
4	11	-4.467	-0.765	-9.379
5	11	-4.546	-0.899	-9.127
6	11	-4.633	-0.946	-8.848
7	11	-4.720	-0.899	-8.570
8	11	-4.799	-0.765	-8.318
9	11	-4.862	-0.556	-8.119
10	11	-4.902	-0.292	-7.990
11	11	-4.916	0.000	-7.946

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Figure 35.- Concluded.

```
XYZ POTENTIAL FLOW PROGRAM SECTION 1, VERSION 4

CONE-CYLINDER MODEL WITH JET- 632 PANELS

NO. OF QUADS.  = 632
NO. OF SECTIONS=   5
MAX. NO. OF ITERATIONS X FLOW 150  Y FLOW 150  Z FLOW 150
1 PLANES OF SYMMETRY

CONVERGENCE CRITERIA , 0.00010

   ISP =  0

IEDIT1 =  0
IEDIT3 =  0
IEDIT4 =  0
ITAPE  =  1

XCENTER = 0.00
YCENTER = 0.00
ZCENTER = 0.00
```

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Figure 36.- Output from Program PFP1 for the sample case.

SECTION 1

M	X1	X2	X3	X4	XP	XN	A	CZ4
N	Y1	Y2	Y3	Y4	YP	YN	FL	CZ5
P	Z1	Z2	Z3	Z4	ZP	ZN	CZ1	CZ6
WARNING LONG THIN QUAD.								
1	0.39000E+02	0.39000E+02	0.35000E+02	0.35000E+02	0.36432E+02	0.16201E+00	0.40620E+00	-0.11683E-04
1	0.00000E+00	-0.14750E-01	-0.18402E+00	0.00000E+00	-0.61705E-01	-0.12877E+00	0.20267E+01	-0.77735E+00
1	0.57000E-01	0.55060E-01	0.68677E+00	0.71100E+00	0.46870E+00	0.97835E+00	0.30534E-02	-0.32801E-01
WARNING LONG THIN QUAD.								
1	0.35000E+02	0.35000E+02	0.30000E+02	0.30000E+02	0.32196E+02	0.16249E+00	0.14803E+01	-0.40606E+00
2	0.00000E+00	-0.18402E+00	-0.39548E+00	0.00000E+00	-0.15131E+00	-0.12880E+00	0.25368E+01	0.16945E-03
2	0.71100E+00	0.68677E+00	0.14759E+01	0.15280E+01	0.11493E+01	0.97627E+00	0.95231E-02	0.46194E-06
WARNING LONG THIN QUAD.								
2	0.39000E+02	0.39000E+02	0.35000E+02	0.35000E+02	0.36432E+02	0.16201E+00	0.40622E+00	-0.77768E+00
1	-0.14750E-01	-0.28500E-01	-0.35550E+00	-0.18402E+00	-0.18091E+00	-0.37772E+00	0.20267E+01	0.33421E-03
3	0.55060E-01	0.49360E-01	0.61574E+00	0.68677E+00	0.43675E+00	0.91163E+00	0.30523E-02	-0.68575E-04
WARNING LONG THIN QUAD.								
2	0.35000E+02	0.35000E+02	0.30000E+02	0.30000E+02	0.32196E+02	0.16249E+00	0.14803E+01	-0.10528E-04
2	-0.18402E+00	-0.35550E+00	-0.76400E+00	-0.39548E+00	-0.44360E+00	-0.37759E+00	0.25368E+01	-0.40587E+00
4	0.68677E+00	0.61574E+00	0.13233E+01	0.14759E+01	0.10709E+01	0.91160E+00	0.95234E-02	0.17100E-01
WARNING LONG THIN QUAD.								
3	0.39000E+02	0.39000E+02	0.35000E+02	0.35000E+02	0.36432E+02	0.16201E+00	0.40620E+00	-0.14073E-04
1	-0.28500E-01	-0.40310E-01	-0.50275E+00	-0.35550E+00	-0.28779E+00	-0.60054E+00	0.20267E+01	-0.77761E+00
5	0.49360E-01	0.40310E-01	0.50275E+00	0.61574E+00	0.37505E+00	0.78301E+00	0.30524E-02	[illegible]2935E-01
WARNING LONG THIN QUAD.								
3	0.35000E+02	0.35000E+02	0.30000E+02	0.30000E+02	0.32196E+02	0.16249E+00	0.14803E+01	-0.40607E+00
2	-0.35550E+00	-0.50275E+00	-0.10805E+01	-0.76400E+00	-0.70567E+00	-0.60067E+00	0.25368E+01	0.16967E-03
6	0.61574E+00	0.50275E+00	0.10805E+01	0.13233E+01	0.91964E+00	0.78281E+00	0.95228E-02	0.66683E-06
WARNING LONG THIN QUAD.								
4	0.39000E+02	0.39000E+02	0.35000E+02	0.35000E+02	0.36432E+02	0.16201E+00	0.40620E+00	-0.77795E+00
1	-0.40310E-01	-0.49360E-01	-0.61574E+00	-0.50275E+00	-0.37505E+00	-0.78301E+00	0.20267E+01	0.33451E-03
7	0.40310E-01	0.28500E-01	0.35550E+00	0.50275E+00	0.28779E+00	0.60054E+00	0.30524E-02	-0.16081E-03
WARNING LONG THIN QUAD.								
4	0.35000E+02	0.35000E+02	0.30000E+02	0.30000E+02	0.32196E+02	0.16249E+00	0.14803E+01	-0.10322E-04
2	-0.50275E+00	-0.61574E+00	-0.13233E+01	-0.10805E+01	-0.91964E+00	-0.78281E+00	0.25368E+01	-0.40589E+00
8	0.50275E+00	0.35550E+00	0.76400E+00	0.10805E+01	0.70567E+00	0.60067E+00	0.95229E-02	0.17098E-01
WARNING LONG THIN QUAD.								
5	0.39000E+02	0.39000E+02	0.35000E+02	0.35000E+02	0.36432E+02	0.16201E+00	0.40622E+00	-0.12318E-04
1	-0.49360E-01	-0.55060E-01	-0.68677E+00	-0.61574E+00	-0.43675E+00	-0.91164E+00	0.20267E+01	-0.77734E+00
9	0.28500E-01	0.14750E-01	0.18402E+00	0.35550E+00	0.18091E+00	0.37772E+00	0.30523E-02	-0.32832E-01
WARNING LONG THIN QUAD.								
5	0.35000E+02	0.35000E+02	0.30000E+02	0.30000E+02	0.32196E+02	0.16249E+00	0.14803E+01	-0.40606E+00
2	-0.61574E+00	-0.68677E+00	-0.14759E+01	-0.13233E+01	-0.10709E+01	-0.91160E+00	0.25368E+01	0.16951E-03
10	0.35550E+00	0.18402E+00	0.39548E+00	0.76400E+00	0.44360E+00	0.37759E+00	0.95227E-02	0.30398E-05

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Figure 36.- Continued.

```
 M      X1           X2           X3           X4           XP           XN           A            CZ4
 N      Y1           Y2           Y3           Y4           YP           YN           FL           CZ5
 P      Z1           Z2           Z3           Z4           ZP           ZN           CZ1          CZ6

QUESTIONABLE POINT - INWARD NORMAL
  6  -0.18173E+01 -0.24137E+01 -0.24642E+01 -0.18715E+01 -0.21462E+01 -0.33081E+00  0.15415E+00  0.53071E-01
  9  -0.42583E+00 -0.46738E+00 -0.24572E+00 -0.22387E+00 -0.34125E+00 -0.45160E+00  0.34552E+00 -0.69485E+00
623  -0.70483E+01 -0.73124E+01 -0.72114E+01 -0.69609E+01 -0.71353E+01  0.82863E+00  0.41663E-02  0.18587E-01

QUESTIONABLE POINT - INWARD NORMAL
  6  -0.18715E+01 -0.24642E+01 -0.24816E+01 -0.18902E+01 -0.21815E+01 -0.37620E+00  0.15263E+00 -0.69486E+00
 10  -0.22387E+00 -0.24572E+00  0.00000E+00  0.00000E+00 -0.11758E+00 -0.15563E+00  0.34238E+00  0.60701E-01
624  -0.69609E+01 -0.72114E+01 -0.71766E+01 -0.69307E+01 -0.70719E+01  0.91337E+00  0.36228E-02  0.14239E-01

QUESTIONABLE POINT - INWARD NORMAL
  7  -0.24137E+01 -0.30201E+01 -0.30675E+01 -0.24642E+01 -0.27448E+01 -0.29019E+00  0.16623E+00 -0.64298E+00
  9  -0.46738E+00 -0.50056E+00 -0.26316E+00 -0.24572E+00 -0.36954E+00 -0.45235E+00  0.34750E+00  0.15840E-01
625  -0.73124E+01 -0.75411E+01 -0.74298E+01 -0.72114E+01 -0.73751E+01  0.84331E+00  0.90846E-02 -0.13050E-01

QUESTIONABLE POINT - INWARD NORMAL
  7  -0.24642E+01 -0.30675E+01 -0.30839E+01 -0.24816E+01 -0.27778E+01 -0.32979E+00  0.16501E+00  0.19375E-01
 10  -0.24572E+00 -0.26316E+00  0.00000E+00  0.00000E+00 -0.12735E+00 -0.15588E+00  0.34523E+00 -0.64286E+00
626  -0.72114E+01 -0.74298E+01 -0.73914E+01 -0.71766E+01 -0.73035E+01  0.93110E+00  0.86678E-02 -0.19626E-01

QUESTIONABLE POINT - INWARD NORMAL
  8  -0.30201E+01 -0.36317E+01 -0.36762E+01 -0.30675E+01 -0.33512E+01 -0.27080E+00  0.17565E+00  0.15942E-01
  9  -0.50056E+00 -0.52424E+00 -0.27561E+00 -0.26316E+00 -0.39115E+00 -0.45327E+00  0.34971E+00 -0.60904E+00
627  -0.75411E+01 -0.77502E+01 -0.76316E+01 -0.74298E+01 -0.75890E+01  0.84924E+00  0.96499E-02  0.10276E-01

QUESTIONABLE POINT - INWARD NORMAL
  8  -0.30675E+01 -0.36762E+01 -0.36915E+01 -0.30839E+01 -0.33821E+01 -0.30625E+00  0.17466E+00 -0.60900E+00
 10  -0.26316E+00 -0.27561E+00  0.00000E+00  0.00000E+00 -0.13478E+00 -0.15621E+00  0.34802E+00  0.19541E-01
628  -0.74298E+01 -0.76316E+01 -0.75907E+01 -0.73914E+01 -0.75117E+01  0.93905E+00  0.93412E-02  0.51404E-02

QUESTIONABLE POINT - INWARD NORMAL
  9  -0.36317E+01 -0.42472E+01 -0.42890E+01 -0.36762E+01 -0.39627E+01 -0.25054E+00  0.18234E+00 -0.58584E+00
  9  -0.52424E+00 -0.54220E+00 -0.28505E+00 -0.27561E+00 -0.40695E+00 -0.45357E+00  0.35130E+00  0.11087E-01
629  -0.77502E+01 -0.79411E+01 -0.78169E+01 -0.76316E+01 -0.77856E+01  0.85528E+00  0.10675E-01 -0.66138E-02

QUESTIONABLE POINT - INWARD NORMAL
  9  -0.36762E+01 -0.42890E+01 -0.43034E+01 -0.36915E+01 -0.39917E+01 -0.28245E+00  0.18152E+00  0.13180E-01
 10  -0.27561E+00 -0.28505E+00  0.00000E+00  0.00000E+00 -0.14023E+00 -0.15630E+00  0.34990E+00 -0.58578E+00
630  -0.76316E+01 -0.78169E+01 -0.77742E+01 -0.75907E+01 -0.77039E+01  0.94646E+00  0.10446E-01 -0.93674E-02

QUESTIONABLE POINT - INWARD NORMAL
 10  -0.42472E+01 -0.48617E+01 -0.49018E+01 -0.42890E+01 -0.45762E+01 -0.23692E+00  0.18652E+00  0.11105E-01
  9  -0.54220E+00 -0.55575E+00 -0.29218E+00 -0.28505E+00 -0.41892E+00 -0.45374E+00  0.35125E+00 -0.56936E+00
631  -0.79411E+01 -0.81185E+01 -0.79904E+01 -0.78169E+01 -0.79671E+01  0.85907E+00  0.11015E-01  0.59893E-02

QUESTIONABLE POINT - INWARD NORMAL
 10  -0.42890E+01 -0.49018E+01 -0.49157E+01 -0.43034E+01 -0.46037E+01 -0.26630E+00  0.18598E+00 -0.56935E+00
 10  -0.28505E+00 -0.29218E+00  0.00000E+00  0.00000E+00 -0.14435E+00 -0.15636E+00  0.35025E+00  0.13220E-01
632  -0.78169E+01 -0.79904E+01 -0.79462E+01 -0.77742E+01 -0.78823E+01  0.95112E+00  0.10821E-01  0.28379E-02
```

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Figure 36.- Continued.

M	X1	X2	X3	X4	XP	XN	A	CZ4
N	Y1	Y2	Y3	Y4	YP	YN	FL	CZ5
P	Z1	Z2	Z3	Z4	ZP	ZN	CZ1	CZ6

EXTRA FLOW -1.00000 0.00000 0.00000

SOLID ANGLE = 12.468

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Figure 36.- Concluded.

JET EXHAUSTING FROM CONE-CYLINDER, VJ/VO = 3.43
CALCULATION OF JET ENTRAINMENT MODEL INDUCED VELOCITIES

NJET	NFIX
1	0

(1) JET PARAMETERS	VJET/VINF	XQ	YQ	ZQ	NCYL
	3.4300	0.0000	0.0000	-5.0000	24

XCL	YCL	ZCL	A	P	SCL	THETA
0.00000	0.00000	0.00000	0.32000	2.011	0.000	0.000
0.00700	0.00000	0.32000	0.37000	2.325	0.320	2.949
0.02000	0.00000	0.48000	0.39500	2.482	0.481	6.237
0.04200	0.00000	0.64000	0.41900	2.633	0.642	9.913
0.07600	0.00000	0.80000	0.44200	2.777	0.806	14.184
0.12300	0.00000	0.96000	0.46400	2.915	0.972	18.931
0.18600	0.00000	1.12000	0.48600	3.054	1.144	23.885
0.26500	0.00000	1.28000	0.50800	3.192	1.323	28.752
0.36200	0.00000	1.44000	0.52900	3.324	1.510	33.584
0.47800	0.00000	1.60000	0.55100	3.462	1.708	38.257
0.61500	0.00000	1.76000	0.57300	3.600	1.918	42.786
0.77500	0.00000	1.92000	0.60500	3.801	2.144	46.918
0.95800	0.00000	2.08000	0.63900	4.015	2.388	50.634
1.16600	0.00000	2.24000	0.67600	4.247	2.650	54.034
1.40000	0.00000	2.40000	0.71200	4.474	2.933	57.064
1.66100	0.00000	2.56000	0.74200	4.662	3.240	59.802
1.95100	0.00000	2.72000	0.77600	4.876	3.571	62.238
2.27000	0.00000	2.88000	0.81100	5.096	3.928	64.367
2.61900	0.00000	3.04000	0.84200	5.290	4.312	66.322
3.00100	0.00000	3.20000	0.87000	5.466	4.726	68.072
3.41500	0.00000	3.36000	0.89400	5.617	5.170	69.608
3.86300	0.00000	3.52000	0.91700	5.762	5.645	71.009
4.34600	0.00000	3.68000	0.93500	5.875	6.154	72.269
4.86500	0.00000	3.84000	0.95400	5.994	6.697	72.866

OPTIONS...

NP	NVEL	NSAVE	NFPTS	NOUTA	NOUTB	NOUTD	NCPBOD
632	1	1	1	0	0	0	100

JET-INDUCED VELOCITIES ARE SPECIFIED AT THE FOLLOWING BODY CONTROL POINTS

CONTROL POINT	SPECIFIED VELOCITIES UP	VP	WP
533	0.00000	0.00000	0.00000
534	0.00000	0.00000	0.00000
535	0.00000	0.00000	0.00000
536	0.00000	0.00000	0.00000
537	0.00000	0.00000	0.00000
538	0.00000	0.00000	0.00000
539	0.00000	0.00000	0.00000
540	0.00000	0.00000	0.00000
541	0.00000	0.00000	0.00000
542	0.00000	0.00000	0.00000
543	0.00000	0.00000	0.00000
544	0.00000	0.00000	0.00000
545	0.00000	0.00000	0.00000
546	0.00000	0.00000	0.00000

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547	0.00000	0.00000	0.00000
548	0.00000	0.00000	0.00000
549	0.00000	0.00000	0.00000
550	0.00000	0.00000	0.00000
551	0.00000	0.00000	0.00000
552	0.00000	0.00000	0.00000
553	0.00000	0.00000	0.00000
554	0.00000	0.00000	0.00000
555	0.00000	0.00000	0.00000
556	0.00000	0.00000	0.00000
557	0.00000	0.00000	0.00000
558	0.00000	0.00000	0.00000
559	0.00000	0.00000	0.00000
560	0.00000	0.00000	0.00000
561	0.00000	0.00000	0.00000
562	0.00000	0.00000	0.00000
563	0.00000	0.00000	0.00000
564	0.00000	0.00000	0.00000
565	0.00000	0.00000	0.00000
566	0.00000	0.00000	0.00000
567	0.00000	0.00000	0.00000
568	0.00000	0.00000	0.00000
569	0.00000	0.00000	0.00000
570	0.00000	0.00000	0.00000
571	0.00000	0.00000	0.00000
572	0.00000	0.00000	0.00000
573	0.00000	0.00000	0.00000
574	0.00000	0.00000	0.00000
575	0.00000	0.00000	0.00000
576	0.00000	0.00000	0.00000
577	0.00000	0.00000	0.00000
578	0.00000	0.00000	0.00000
579	0.00000	0.00000	0.00000
580	0.00000	0.00000	0.00000
581	0.00000	0.00000	0.00000
582	0.00000	0.00000	0.00000
583	0.00000	0.00000	0.00000
584	0.00000	0.00000	0.00000
585	0.00000	0.00000	0.00000
586	0.00000	0.00000	0.00000
587	0.00000	0.00000	0.00000
588	0.00000	0.00000	0.00000
589	0.00000	0.00000	0.00000
590	0.00000	0.00000	0.00000
591	0.00000	0.00000	0.00000
592	0.00000	0.00000	0.00000
593	0.00000	0.00000	0.00000
594	0.00000	0.00000	0.00000
595	0.00000	0.00000	0.00000
596	0.00000	0.00000	0.00000
597	0.00000	0.00000	0.00000
598	0.00000	0.00000	0.00000
599	0.00000	0.00000	0.00000
600	0.00000	0.00000	0.00000
601	0.00000	0.00000	0.00000
602	0.00000	0.00000	0.00000
603	0.00000	0.00000	0.00000
604	0.00000	0.00000	0.00000
605	0.00000	0.00000	0.00000
606	0.00000	0.00000	0.00000
607	0.00000	0.00000	0.00000
608	0.00000	0.00000	0.00000
609	0.00000	0.00000	0.00000
610	0.00000	0.00000	0.00000
611	0.00000	0.00000	0.00000
612	0.00000	0.00000	0.00000

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Figure 37.- Output from Program JETBOD for the sample case, calculation of jet entrainment model induced velocities.

613	0.00000	0.00000	0.00000
614	0.00000	0.00000	0.00000
615	0.00000	0.00000	0.00000
616	0.00000	0.00000	0.00000
617	0.00000	0.00000	0.00000
618	0.00000	0.00000	0.00000
619	0.00000	0.00000	0.00000
620	0.00000	0.00000	0.00000
621	0.00000	0.00000	0.00000
622	0.00000	0.00000	0.00000
623	0.00000	0.00000	0.00000
624	0.00000	0.00000	0.00000
625	0.00000	0.00000	0.00000
626	0.00000	0.00000	0.00000
627	0.00000	0.00000	0.00000
628	0.00000	0.00000	0.00000
629	0.00000	0.00000	0.00000
630	0.00000	0.00000	0.00000
631	0.00000	0.00000	0.00000
632	0.00000	0.00000	0.00000

TOTAL JET INDUCED VELOCITY FIELD IN BODY COORDINATE SYSTEM (FREE-STREAM VELOCITIES NOT INCLUDED)

N	XB	YB	ZB	U/V0	V/V0	W/V0	VT/V0	X/D	PHI
1	36.43227	-0.06170	0.46870	-0.00015	0.00000	-0.00003	0.00015	56.9	172.5
2	32.19592	-0.15131	1.14927	-0.00018	0.00000	-0.00005	0.00019	50.3	172.5
3	36.43232	-0.18091	0.43675	-0.00015	0.00000	-0.00003	0.00015	56.9	157.5
4	32.19593	-0.44360	1.07094	-0.00018	0.00000	-0.00005	0.00019	50.3	157.5
5	36.43229	-0.28779	0.37505	-0.00015	0.00000	-0.00003	0.00015	56.9	142.5
6	32.19591	-0.70567	0.91964	-0.00018	0.00000	-0.00004	0.00019	50.3	142.5
7	36.43229	-0.37505	0.28779	-0.00015	0.00000	-0.00003	0.00015	56.9	127.5
8	32.19591	-0.91964	0.70567	-0.00018	0.00000	-0.00004	0.00019	50.3	127.5
9	36.43232	-0.43675	0.18091	-0.00015	0.00000	-0.00003	0.00015	56.9	112.5
10	32.19593	-1.07094	0.44360	-0.00018	0.00001	-0.00004	0.00019	50.3	112.5
11	36.43227	-0.46870	0.06170	-0.00015	0.00000	-0.00003	0.00015	56.9	97.5
12	32.19592	-1.14927	0.15131	-0.00019	0.00001	-0.00004	0.00019	50.3	97.5
13	36.43227	-0.46870	-0.06170	-0.00015	0.00000	-0.00003	0.00015	56.9	82.5
14	32.19592	-1.14927	-0.15131	-0.00019	0.00001	-0.00004	0.00019	50.3	82.5
15	36.43232	-0.43675	-0.18091	-0.00015	0.00000	-0.00003	0.00015	56.9	67.5
16	32.19593	-1.07094	-0.44360	-0.00019	0.00001	-0.00004	0.00019	50.3	67.5
17	36.43229	-0.37505	-0.28779	-0.00015	0.00000	-0.00002	0.00015	56.9	52.5
18	32.19591	-0.91964	-0.70567	-0.00019	0.00000	-0.00004	0.00019	50.3	52.5
19	36.43229	-0.28779	-0.37505	-0.00015	0.00000	-0.00002	0.00015	56.9	37.5
20	32.19591	-0.70567	-0.91964	-0.00019	0.00000	-0.00004	0.00019	50.3	37.5
21	36.43232	-0.18091	-0.43675	-0.00015	0.00000	-0.00002	0.00015	56.9	22.5
22	32.19593	-0.44360	-1.07094	-0.00019	0.00000	-0.00004	0.00019	50.3	22.5
23	36.43227	-0.06170	-0.46870	-0.00015	0.00000	-0.00002	0.00015	56.9	7.5
24	32.19592	-0.15131	-1.14927	-0.00019	0.00000	-0.00004	0.00019	50.3	7.5
25	27.32422	-0.25432	1.93174	-0.00021	0.00000	-0.00008	0.00022	42.7	172.5
26	22.37637	-0.35894	2.72645	-0.00028	0.00000	-0.00013	0.00031	35.0	172.5
27	27.32420	-0.74563	1.80010	-0.00021	0.00001	-0.00007	0.00022	42.7	157.5
28	22.37637	-1.05237	2.54064	-0.00028	0.00001	-0.00013	0.00031	35.0	157.5
29	27.32421	-1.18612	1.54578	-0.00021	0.00001	-0.00007	0.00022	42.7	142.5
30	22.37637	-1.67408	2.18170	-0.00028	0.00002	-0.00012	0.00031	35.0	142.5
31	27.32421	-1.54578	1.18612	-0.00021	0.00001	-0.00007	0.00023	42.7	127.5
32	22.37637	-2.18170	1.67408	-0.00029	0.00003	-0.00012	0.00031	35.0	127.5
33	27.32420	-1.80010	0.74563	-0.00022	0.00001	-0.00007	0.00023	42.7	112.5
34	22.37637	-2.54064	1.05237	-0.00029	0.00003	-0.00011	0.00032	35.0	112.5
35	27.32422	-1.93174	0.25432	-0.00022	0.00001	-0.00006	0.00023	42.7	97.5
36	22.37637	-2.72645	0.35894	-0.00030	0.00003	-0.00011	0.00032	35.0	97.5
37	27.32422	-1.93174	-0.25432	-0.00025	0.00001	-0.00006	0.00026	42.7	82.5
38	22.37637	-2.72645	-0.35894	-0.00031	0.00004	-0.00010	0.00033	35.0	82.5
39	27.32420	-1.80010	-0.74563	-0.00025	0.00001	-0.00006	0.00026	42.7	67.5
40	22.37637	-2.54064	-1.05237	-0.00032	0.00003	-0.00009	0.00033	35.0	67.5
41	27.32421	-1.54578	-1.18612	-0.00025	0.00001	-0.00005	0.00026	42.7	52.5

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Figure 37.- Concluded.

XYZ POTENTIAL FLOW PROGRAM SECTION 2, VERSION 4

CONE-CYLINDER MODEL WITH JET- 632 PANELS

Figure 38.- Output from Program PF2 for the sample case.

XYZ POTENTIAL FLOW PROGRAM SECTION 3, VERSION 4

CONE-CYLINDER MODEL WITH JET- 632 PANELS

IJET = 1
IEDIT3= 0

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JET INDUCED VELOCITIES

IP	VJETX(IP)	VJETY(IP)	VJETZ(IP)
1	-0.000148	0.000000	-0.000027
2	-0.000182	0.000001	-0.000046
3	-0.000148	0.000001	-0.000027
4	-0.000182	0.000002	-0.000045
5	-0.000148	0.000001	-0.000027
6	-0.000183	0.000003	-0.000045
7	-0.000149	0.000001	-0.000027
8	-0.000183	0.000004	-0.000044
9	-0.000149	0.000002	-0.000026
10	-0.000184	0.000005	-0.000043
11	-0.000149	0.000002	-0.000026
12	-0.000185	0.000006	-0.000041
13	-0.000149	0.000002	-0.000026
14	-0.000186	0.000006	-0.000040
15	-0.000150	0.000002	-0.000025
16	-0.000187	0.000005	-0.000038
17	-0.000150	0.000001	-0.000025
18	-0.000188	0.000005	-0.000037
19	-0.000150	0.000001	-0.000025
20	-0.000189	0.000004	-0.000036
21	-0.000150	0.000001	-0.000024
22	-0.000189	0.000002	-0.000035
23	-0.000150	0.000000	-0.000024
24	-0.000190	0.000001	-0.000035
25	-0.000210	0.000002	-0.000075
26	-0.000278	0.000004	-0.000130
27	-0.000211	0.000005	-0.000075
28	-0.000280	0.000012	-0.000128
29	-0.000212	0.000009	-0.000073
30	-0.000283	0.000020	-0.000125
31	-0.000214	0.000011	-0.000071
32	-0.000288	0.000026	-0.000120
33	-0.000216	0.000013	-0.000068
34	-0.000294	0.000031	-0.000114
35	-0.000219	0.000015	-0.000064
36	-0.000301	0.000034	-0.000108
37	-0.000247	0.000015	-0.000061
38	-0.000308	0.000035	-0.000100
39	-0.000250	0.000014	-0.000057
40	-0.000316	0.000034	-0.000092
41	-0.000253	0.000012	-0.000054
42	-0.000323	0.000029	-0.000085
43	-0.000255	0.000009	-0.000051
44	-0.000329	0.000023	-0.000079
45	-0.000257	0.000006	-0.000050
46	-0.000333	0.000015	-0.000075
47	-0.000258	0.000002	-0.000049
48	-0.000335	0.000005	-0.000072
49	-0.000410	0.000009	-0.000234
50	-0.000541	0.000022	-0.000485
51	-0.000415	0.000027	-0.000231
52	-0.000552	0.000072	-0.000483
53	-0.000424	0.000044	-0.000226
54	-0.000570	0.000120	-0.000478
55	-0.000437	0.000064	-0.000218
56	-0.000613	0.000167	-0.000470
57	-0.000454	0.000078	-0.000207
58	-0.000664	0.000211	-0.000458
59	-0.000475	0.000037	-0.000195
60	-0.000730	0.000249	-0.000400
61	-0.000498	0.000092	-0.000180

(b) Page 2

Figure 39.- Output from Program PFP3 for the sample case.

```
590    0.000000    0.000000    0.000000
591    0.000000    0.000000    0.000000
592    0.000000    0.000000    0.000000
593    0.000000    0.000000    0.000000
594    0.000000    0.000000    0.000000
595    0.000000    0.000000    0.000000
596    0.000000    0.000000    0.000000
597    0.000000    0.000000    0.000000
598    0.000000    0.000000    0.000000
599    0.000000    0.000000    0.000000
600    0.000000    0.000000    0.000000
601    0.000000    0.000000    0.000000
602    0.000000    0.000000    0.000000
603    0.000000    0.000000    0.000000
604    0.000000    0.000000    0.000000
605    0.000000    0.000000    0.000000
606    0.000000    0.000000    0.000000
607    0.000000    0.000000    0.000000
608    0.000000    0.000000    0.000000
609    0.000000    0.000000    0.000000
610    0.000000    0.000000    0.000000
611    0.000000    0.000000    0.000000
612    0.000000    0.000000    0.000000
613    0.000000    0.000000    0.000000
614    0.000000    0.000000    0.000000
615    0.000000    0.000000    0.000000
616    0.000000    0.000000    0.000000
617    0.000000    0.000000    0.000000
618    0.000000    0.000000    0.000000
619    0.000000    0.000000    0.000000
620    0.000000    0.000000    0.000000
621    0.000000    0.000000    0.000000
622    0.000000    0.000000    0.000000
623    0.000000    0.000000    0.000000
624    0.000000    0.000000    0.000000
625    0.000000    0.000000    0.000000
626    0.000000    0.000000    0.000000
627    0.000000    0.000000    0.000000
628    0.000000    0.000000    0.000000
629    0.000000    0.000000    0.000000
630    0.000000    0.000000    0.000000
631    0.000000    0.000000    0.000000
632    0.000000    0.000000    0.000000

X VELOCITY=-1.0    Y VELOCITY= 0.0    Z VELOCITY= 0.0

ITERATION   SUM OF CHANGES        A           B1          B2
    1        0.35916E+01
    2        0.22750E+01
    3        0.20326E+01
    4        0.19259E+01
    5        0.18297E+01
                              0.513E+00   0.403E+00   0.645E+00
    6        0.17484E+01
    7        0.16783E+01
    8        0.16170E+01
    9        0.15628E+01
   10        0.15150E+01
                            A EXTRAPOLATION
                              0.508E+00   0.499E+00   0.263E+00
   11        0.37754E-01
   12        0.33963E-01
   13        0.30765E-01
   14        0.27992E-01
   15        0.25582E-01
                            A EXTRAPOLATION
```

(c) Page 11

```
                              0.522E+00   0.498E+00   0.309E+00
   16        0.73964E-03

X VELOCITY= 0.0    Y VELOCITY=-1.0    Z VELOCITY= 0.0

ITERATION   SUM OF CHANGES        A           B1          B2
    1        0.21026E+02
    2        0.31260E+01
    3        0.54235E+00
    4        0.11595E+00
    5        0.24410E-01
                              0.126E+01  -0.278E+00   0.127E+01
    6        0.54499E-02
    7        0.11667E-02

X VELOCITY= 0.0    Y VELOCITY= 0.0    Z VELOCITY=-1.0

ITERATION   SUM OF CHANGES        A           B1          B2
    1        0.15903E+02
    2        0.21009E+01
    3        0.71634E+00
    4        0.57885E+00
    5        0.49444E+00
                              0.539E+00   0.439E+00   0.649E+00
    6        0.42517E+00
    7        0.36906E+00
    8        0.32287E+00
    9        0.28428E+00
   10        0.25172E+00
                            A EXTRAPOLATION
                              0.530E+00   0.494E+00   0.314E+00
   11        0.38807E-02
```

(d) Page 12

Figure 39.- Concluded.

```
XYP POTENTIAL FLOW PROGRAM SECTION 4, VERSION 4
CONE-CYLINDER MODEL WITH JET- 632 PANELS

IJET  =  1
IEDIT =  0
IFLOW =  0
IFORCE=  0
```

(a) Page 1

Figure 40.- Output from Program PFP4 for the sample case.

CONE-CYLINDER MODEL WITH JET- 632 PANELS PAGE = 1

X FLOW

PT.	X	Y	Z	VX	VY	VZ	ABS.V	CP	SOURCE	V NORMAL
1	36.43227	-0.06170	0.46870	-0.92132	-0.01976	0.15013	0.93368	0.12823	0.01196	0.16E-03
2	32.19592	-0.15131	1.14927	-0.93284	-0.02005	0.15230	0.94541	0.10621	0.01211	0.15E-05
3	36.43232	-0.18091	0.43675	-0.92132	-0.05793	0.13991	0.93368	0.12823	0.01197	0.16E-03
4	32.19593	-0.44360	1.07094	-0.93284	-0.05877	0.14193	0.94540	0.10621	0.01211	0.17E-05
5	36.43229	-0.28779	0.37505	-0.92132	-0.09215	0.12016	0.93368	0.12823	0.01196	0.16E-03
6	32.19591	-0.70567	0.91964	-0.93284	-0.09349	0.12189	0.94540	0.10621	0.01211	0.17E-05
7	36.43229	-0.37505	0.28779	-0.92132	-0.12012	0.09220	0.93368	0.12824	0.01197	0.16E-03
8	32.19591	-0.91964	0.70567	-0.93284	-0.12185	0.09355	0.94540	0.10622	0.01211	0.15E-05
9	36.43232	-0.43675	0.18091	-0.92132	-0.13988	0.05799	0.93368	0.12824	0.01197	0.16E-03
10	32.19593	-1.07094	0.44360	-0.93283	-0.14191	0.05883	0.94540	0.10622	0.01211	0.19E-05
11	36.43227	-0.46870	0.06170	-0.92132	-0.15012	0.01980	0.93368	0.12825	0.01197	0.16E-03
12	32.19592	-1.14927	0.15131	-0.93283	-0.15229	0.02010	0.94540	0.10623	0.01211	0.20E-05
13	36.43227	-0.46870	-0.06170	-0.92132	-0.15013	-0.01972	0.93368	0.12825	0.01197	0.16E-03
14	32.19592	-1.14927	-0.15131	-0.93283	-0.15231	-0.02000	0.94539	0.10623	0.01211	0.19E-05
15	36.43232	-0.43675	-0.18091	-0.92131	-0.13991	-0.05791	0.93367	0.12825	0.01197	0.16E-03
16	32.19593	-1.07094	-0.44360	-0.93282	-0.14194	-0.05874	0.94539	0.10624	0.01212	0.20E-05
17	36.43229	-0.37505	-0.28779	-0.92131	-0.12016	-0.09215	0.93367	0.12826	0.01197	0.16E-03
18	32.19591	-0.91964	-0.70567	-0.93282	-0.12190	-0.09348	0.94539	0.10625	0.01212	0.14E-05
19	36.43229	-0.28779	-0.37505	-0.92131	-0.09219	-0.12012	0.93367	0.12826	0.01197	0.16E-03
20	32.19591	-0.70567	-0.91964	-0.93282	-0.09354	-0.12185	0.94538	0.10625	0.01212	0.15E-05
21	36.43232	-0.18091	-0.43675	-0.92131	-0.05797	-0.13989	0.93367	0.12826	0.01197	0.16E-03
22	32.19593	-0.44360	-1.07094	-0.93282	-0.05880	-0.14191	0.94538	0.10626	0.01212	0.14E-05
23	36.43227	-0.06170	-0.46870	-0.92131	-0.01977	-0.15013	0.93367	0.12826	0.01197	0.16E-03
24	32.19592	-0.15131	-1.[illegible]27	-0.93282	-0.02006	-0.15230	0.94538	0.10626	0.01212	0.14E-05
25	27.32422	-0.25432	1.93174	-0.94400	-0.02030	0.15428	0.95674	0.08465	0.01306	0.91E-05
26	22.37637	-0.35894	2.72645	-0.95742	-0.02059	0.15651	0.97034	0.05844	0.01336	0.76E-05
27	27.32420	-0.74563	1.80010	-0.94400	-0.05952	0.14377	0.95674	0.08465	0.01306	0.90E-05
28	22.37637	-1.05237	2.54064	-0.95741	-0.06037	0.14585	0.97034	0.05844	0.01336	0.77E-05
29	27.32421	-1.18612	1.54578	-0.94400	-0.09469	0.12348	0.95674	0.08466	0.01306	0.89E-05
30	22.37637	-1.67408	2.18170	-0.95741	-0.09604	0.12527	0.97033	0.05845	0.01336	0.7[illegible]E-05
31	27.32421	-1.54578	1.18612	-0.94399	-0.12341	0.09477	0.95673	0.08467	0.01306	0.91E-05
32	22.37637	-2.18170	1.67408	-0.95740	-0.12518	0.09616	0.97033	0.05847	0.01337	0.77E-05
33	27.32420	-1.80010	0.74563	-0.94399	-0.14373	0.05961	0.95673	0.08467	0.01306	0.92E-05
34	22.37637	-2.54064	1.05237	-0.95739	-0.14579	0.06050	0.97031	0.05849	0.01337	0.76E-05
35	27.32422	-1.93174	0.25432	-0.94398	-0.15426	0.02039	0.95672	0.08468	0.01306	0.91E-05
36	22.37637	-2.72645	0.35894	-0.95738	-0.15648	0.02072	0.97030	0.05852	0.01337	0.77E-05
37	27.32422	-1.93174	-0.25432	-0.94400	-0.15429	-0.02023	0.95674	0.08465	0.01307	0.89E-05
38	22.37637	-2.72645	-0.35894	-0.95736	-0.15651	-0.02048	0.97029	0.05854	0.01337	0.75E-05
39	27.32420	-1.80010	-0.74563	-0.94400	-0.14379	-0.05948	0.95674	0.08466	0.01307	0.89E-05
40	22.37637	-2.54064	-1.05237	-0.95735	-0.14587	-0.06029	0.97027	0.05857	0.01337	0.75E-05
41	27.32421	-1.54578	-1.18612	-0.94399	-0.12349	-0.09467	0.95673	0.08467	0.01307	0.90E-05
42	22.37637	-2.18170	-1.67408	-0.95733	-0.12529	-0.09600	0.97026	0.05860	0.01338	0.75E-05
43	27.32421	-1.18612	-1.54578	-0.94399	-0.09477	-0.12342	0.95673	0.08468	0.01307	0.91E-05
44	22.37637	-1.67408	-2.18170	-0.95732	-0.09616	-0.12517	0.97024	0.05863	0.01338	0.75E-05
45	27.32420	-0.74563	-1.80010	-0.94398	-0.05958	-0.14375	0.95672	0.08468	0.01307	0.89E-05
46	22.37637	-1.05237	-2.54064	-0.95731	-0.06046	-0.14580	0.97024	0.05864	0.01338	0.73E-05
47	27.32422	-0.25432	-1.93174	-0.94398	-0.02032	-0.15427	0.95672	0.08469	0.01307	0.92E-05
48	22.37637	-0.35894	-2.72645	-0.95731	-0.02062	-0.15648	0.97023	0.05865	0.01338	0.76E-05
49	17.40466	-0.46407	3.52498	-0.97359	-0.02094	0.15916	0.98674	0.02635	0.01391	0.53E-05
50	11.48827	-0.58905	4.47425	-1.02439	-0.02200	0.16716	1.03818	-0.07781	0.01655	0.30E-05

(b) Page 2

Figure 40.- Continued.

CONE-CYLINDER MODEL WITH JET- 632 PANELS PAGE = 40

ONSET FLOW, VXI=-1.000 VYI= 0.000 VZI= 0.000

PT.	X	Y	Z	VX	VY	VZ	ABS.V	CP
1	36.43227	-0.06170	0.46870	-0.92132	-0.01976	0.15013	0.93368	0.12823
2	32.19592	-0.15131	1.14927	-0.93284	-0.02005	0.15230	0.94541	0.10621
3	36.43232	-0.18091	0.43675	-0.92132	-0.05793	0.13991	0.93368	0.12823
4	32.19593	-0.44360	1.07094	-0.93284	-0.05877	0.14193	0.94540	0.10621
5	36.43229	-0.28779	0.37505	-0.92132	-0.09215	0.12016	0.93368	0.12823
6	32.19591	-0.70567	0.91964	-0.93284	-0.09349	0.12189	0.94540	0.10621
7	36.43229	-0.37505	0.28779	-0.92132	-0.12012	0.09220	0.93368	0.12824
8	32.19591	-0.91964	0.70567	-0.93284	-0.12185	0.09355	0.94540	0.10622
9	36.43232	-0.43675	0.18091	-0.92132	-0.13988	0.05799	0.93368	0.12824
10	32.19593	-1.07094	0.44360	-0.93283	-0.14191	0.05883	0.94540	0.10622
11	36.43227	-0.46870	0.06170	-0.92132	-0.15012	0.01980	0.93368	0.12825
12	32.19592	-1.14927	0.15131	-0.93283	-0.15229	0.02010	0.94540	0.10623
13	36.43227	-0.46870	-0.06170	-0.92132	-0.15013	-0.01972	0.93368	0.12825
14	32.19592	-1.14927	-0.15131	-0.93283	-0.15231	-0.02000	0.94539	0.10623
15	36.43232	-0.43675	-0.18091	-0.92131	-0.13991	-0.05791	0.93367	0.12825
16	32.19593	-1.07094	-0.44360	-0.93282	-0.14194	-0.05874	0.94539	0.10624
17	36.43229	-0.37505	-0.28779	-0.92131	-0.12016	-0.09215	0.93367	0.12826
18	32.19591	-0.91964	-0.70567	-0.93282	-0.12190	-0.09348	0.94539	0.10625
19	36.43229	-0.28779	-0.37505	-0.92131	-0.09219	-0.12012	0.93367	0.12826
20	32.19591	-0.70567	-0.91964	-0.93282	-0.09354	-0.12185	0.94538	0.10625
21	36.43232	-0.18091	-0.43675	-0.92131	-0.05797	-0.13989	0.93367	0.12826
22	32.19593	-0.44360	-1.07094	-0.93282	-0.05880	-0.14191	0.94538	0.10626
23	36.43227	-0.06170	-0.46870	-0.92131	-0.01977	-0.15013	0.93367	0.12826
24	32.19592	-0.15131	-1.14927	-0.93282	-0.02006	-0.15230	0.94538	0.10626
25	27.32422	-0.25432	1.93174	-0.94400	-0.02030	0.15428	0.95674	0.08465
26	22.37637	-0.35894	2.72645	-0.95742	-0.02059	0.15651	0.97034	0.05844
27	27.32420	-0.74563	1.80010	-0.94400	-0.05952	0.14377	0.95674	0.08465
28	22.37637	-1.05237	2.54064	-0.95741	-0.06037	0.14585	0.97034	0.05844
29	27.32421	-1.18612	1.54578	-0.94400	-0.09469	0.12348	0.95674	0.08466
30	22.37637	-1.67408	2.18170	-0.95741	-0.09604	0.12527	0.97033	0.05845
31	27.32421	-1.54578	1.18612	-0.94399	-0.12341	0.09477	0.95673	0.08467
32	22.37637	-2.18170	1.67408	-0.95740	-0.12518	0.09616	0.97033	0.05847
33	27.32420	-1.80010	0.74563	-0.94399	-0.14373	0.05961	0.95673	0.08467
34	22.37637	-2.54064	1.05237	-0.95739	-0.14579	0.06050	0.97031	0.05849
35	27.32422	-1.93174	0.25432	-0.94398	-0.15426	0.02039	0.95672	0.08468
36	22.37637	-2.72645	0.35894	-0.95738	-0.15648	0.02072	0.97030	0.05852
37	27.32422	-1.93174	-0.25432	-0.94400	-0.15429	-0.02023	0.95674	0.08465
38	22.37637	-2.72645	-0.35894	-0.95736	-0.15651	-0.02048	0.97029	0.05854
39	27.32420	-1.80010	-0.74563	-0.94400	-0.14379	-0.05948	0.95674	0.08466
40	22.37637	-2.54064	-1.05237	-0.95735	-0.14587	-0.06029	0.97027	0.05857
41	27.32421	-1.54578	-1.18612	-0.94399	-0.12349	-0.09467	0.95673	0.08467
42	22.37637	-2.18170	-1.67408	-0.95733	-0.12529	-0.09600	0.97026	0.0586[illegible]
43	27.32421	-1.18612	-1.54578	-0.94399	-0.09477	-0.12342	0.95673	0.08468
44	22.37637	-1.67408	-2.18170	-0.95732	-0.09616	-0.12517	0.97024	0.05863
45	27.32420	-0.74563	-1.80010	-0.94398	-0.05958	-0.14375	0.95672	0.08469
46	22.37637	-1.05237	-2.54064	-0.95731	-0.06046	-0.14580	0.97024	0.05864
47	27.32422	-0.25432	-1.93174	-0.94398	-0.02032	-0.15427	0.95672	0.08469
48	22.37637	-0.35894	-2.72645	-0.95731	-0.02062	-0.15648	0.97023	0.05865
49	17.40466	-0.46407	3.52498	-0.97359	-0.02094	0.15916	0.98674	0.02635
50	11.48827	-0.58905	4.47425	-1.02439	-0.02200	0.16716	1.03818	-0.07781

(c) Page 41

Figure 40.- Concluded.

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        JET EXHAUSTING FROM A CONE-CYLINDER, VJ/VO = 3.43
        VISCOUS CORRELATION FACTORS ADDED TO CP(POTENTIAL)

 NJET  NFIX
   1     1

(1)  JET PARAMETERS     VJET/VINF      XQ        YQ        ZQ      NCYL
                           3.4300   0.0000    0.0000   -5.0800     24

        INITIAL JET RADIUS =    0.32000

   OPTIONS...
      NP   NVEL NSAVE NFPTS NOUTA NOUTB NOUTD NCPBOD
     532     0     0     0     0     0     0     0
```

(a) Page 1

Figure 41.- Output from Program JETBOD for the sample case, determination of viscous correlation factors.

PREDICTED PRESSURE COEFFICIENTS INDUCED ON A
BODY OF REVOLUTION BY A JET EXHAUSTING FROM THE BODY

VJET/VINF = 3.430

J	BODY COORDINATES X	Y	Z	X/D	PHI, DEGREES	CP, THEORETICAL	DELTA CP	CP, CORRELATION
1	36.43227	-0.06170	0.46870	56.93	172.500	0.12823	0.00000	0.12823
2	32.19592	-0.15131	1.14927	50.31	172.500	0.10621	0.00000	0.10621
3	36.43232	-0.18091	0.43675	56.93	157.500	0.12823	0.00000	0.12823
4	32.19593	-0.44360	1.07094	50.31	157.500	0.10621	0.00000	0.10621
5	36.43229	-0.28779	0.37505	56.93	142.500	0.12823	0.00000	0.12823
6	32.19591	-0.70567	0.91964	50.31	142.500	0.10621	0.00000	0.10621
7	36.43229	-0.37505	0.28779	56.93	127.500	0.12824	0.00000	0.12824
8	32.19591	-0.91964	0.70567	50.31	127.500	0.10622	0.00000	0.10622
9	36.43232	-0.43675	0.18091	56.93	112.500	0.12824	0.00000	0.12824
10	32.19593	-1.07094	0.44360	50.31	112.500	0.10622	0.00000	0.10622
11	36.43227	-0.46870	0.06170	56.93	97.500	0.12825	0.00000	0.12825
12	32.19592	-1.14927	0.15131	50.31	97.500	0.10623	0.00000	0.10623
13	36.43227	-0.46870	-0.06170	56.93	82.500	0.12825	0.00000	0.12825
14	32.19592	-1.14927	-0.15131	50.31	82.500	0.10623	0.00000	0.10623
15	36.43232	-0.43675	-0.18091	56.93	67.500	0.12825	0.00000	0.12825
16	32.19593	-1.07094	-0.44360	50.31	67.500	0.10624	0.00000	0.10624
17	36.43229	-0.37505	-0.28779	56.93	52.500	0.12826	0.00000	0.12826
18	32.19591	-0.91964	-0.70567	50.31	52.500	0.10625	0.00000	0.10625
19	36.43229	-0.28779	-0.37505	56.93	37.500	0.12826	0.00000	0.12826
20	32.19591	-0.70567	-0.91964	50.31	37.500	0.10625	0.00000	0.10625
21	36.43232	-0.18091	-0.43675	56.93	22.500	0.12826	0.00000	0.12826
22	32.19593	-0.44360	-1.07094	50.31	22.500	0.10626	0.00000	0.10626
23	36.43227	-0.06170	-0.46870	56.93	7.500	0.12826	0.00000	0.12826
24	32.19592	-0.15131	-1.14927	50.31	7.500	0.10626	0.00000	0.10626
25	27.32422	-0.25432	1.93174	42.69	172.500	0.08465	0.00000	0.08465
26	22.37637	-0.3[illegible]	2.72645	34.96	172.500	0.05844	0.00000	0.05844
27	27.32420	-0.74[illegible]	1.80010	42.69	157.500	0.08465	0.00000	0.08465
28	22.37637	-1.05237	2.54064	34.96	157.500	0.05844	0.00000	0.05844
29	27.32421	-1.18612	1.54578	42.69	142.500	0.08466	0.00000	0.08466
30	22.37637	-1.67408	2.18170	34.96	142.500	0.05845	0.00000	0.05845
31	27.32421	-1.54578	1.18612	42.69	127.500	0.08467	0.00000	0.08467
32	22.37637	-2.18170	1.67408	34.96	127.500	0.05847	0.00000	0.05847
33	27.32420	-1.80010	0.74563	42.69	112.500	0.08467	0.00000	0.08467
34	22.37637	-2.54064	1.05237	34.96	112.500	0.05849	0.00000	0.05849
35	27.32422	-1.93174	0.25432	42.69	97.500	0.08468	0.00000	0.08468
36	22.37637	-2.72645	0.35894	34.96	97.500	0.05852	0.00000	0.05852
37	27.32422	-1.93174	-0.25432	42.69	82.500	0.08465	0.00000	0.08465
38	22.37637	-2.72645	-0.35894	34.96	82.500	0.05854	0.00000	0.05854
39	27.32420	-1.80010	-0.74563	42.69	67.500	0.08466	0.00000	0.08466
40	22.37637	-2.54064	-1.05237	34.96	67.500	0.05857	0.00000	0.05857
41	27.32421	-1.54578	-1.18612	42.69	52.500	0.08467	0.00000	0.08467
42	22.37637	-2.18170	-1.67408	34.96	52.500	0.05860	0.00000	0.05860
43	27.32421	-1.18612	-1.54578	42.69	37.500	0.08468	0.00000	0.08468
44	22.37637	-1.67408	-2.18170	34.96	37.500	0.05863	0.00000	0.05863
45	27.32420	-0.74563	-1.80010	42.69	22.500	0.08468	0.00000	0.08468
46	22.37637	-1.05237	-2.54064	34.96	22.500	0.05864	0.00000	0.05864
47	27.32422	-0.25432	-1.93174	42.69	7.500	0.08469	0.00000	0.08469
48	22.37637	-0.35894	-2.72645	34.96	7.500	0.05865	0.00000	0.05865
49	17.40466	-0.46407	3.52498	27.19	172.500	0.02635	0.00000	0.02635
50	11.48827	-0.58905	4.47425	17.95	172.500	-0.07781	0.00000	-0.07781
51	17.40466	-1.36059	3.28476	27.19	157.500	0.02636	0.00000	0.02636
52	11.48827	-1.72700	4.16934	17.95	157.500	-0.07782	0.00000	-0.07782
53	17.40466	-2.16439	2.82069	27.19	142.500	0.02636	0.00000	0.02636
54	11.48827	-2.74726	3.58029	17.95	142.500	-0.07784	0.00000	-0.07784
55	17.40466	-2.82069	2.16439	27.19	127.500	0.02638	0.00000	0.02638
56	11.48827	-3.58029	2.74726	17.95	127.500	-0.07784	0.00000	-0.07784

(b) Page 2

Figure 41.- Concluded.